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CIVIL ENGINEERING.

*Description of the Compressed Air Engine at Govan Colliery.**

By W. C. RANDOLPH.

[Read before the Institution of Mechanical Engineers, Glasgow.]

This engine was designed for a special purpose in the working of the Govan Colliery, near Glasgow, where an ordinary engine was not applicable; and although under other circumstances not an economical mode of employing power, it has proved in the present case highly satisfactory, and has worked successfully for several years.

The main shaft is sunk 176 yards deep, through six successive seams of coal, the first of which is 92 yards from the surface at that point; and after working the coal at that part, a main road was driven horizontally to a distance 706 yards, intersecting the coal seams, which dip at an inclination of about 1 in 11. A second shaft, at present 26 yards deep, was then sunk near the extremity of the main road, for the purpose of working the third seam, or "rough main" coal. The difficulty then arose of providing for the winding and pumping of this second shaft at a distance of nearly half a mile from the first shaft. A steam boiler was inadmissible in that situation, and the distance was too great to convey steam from the surface. Some application of water power was contemplated by the manager, Mr. James Allan, who applied to the author for the purpose of carrying it out; and it was then proposed by the author, upon the original idea suggested by Mr. David Elder, to make use of compressed air supplied by a compressing steam engine at the surface, and conveyed down by a pipe, to work an engine

*From the Lond. Mech. Mag., Feb., 1857.

at the top of the second shaft, in the manner of a non-condensing steam engine, the discharged air being thrown into the workings to aid in the ventilation of the mine. This proposal was adopted, and the present engine was designed and constructed for the purpose, by Messrs. Randolph, Elliot & Co.; it has now been working at the colliery more than six years, and has been found to answer the purpose completely.

The main shaft contains a single winding apparatus and a set of four pumps, and forms the downcast shaft for the ventilation; it is 18 feet long and 8 feet wide, being oval at the top and rectangular below. It opens at the bottom to the horizontal main road, which is 9 feet wide and 6 feet high, divided by a brattice in the centre throughout the whole length, for the downcast and upcast currents. The upcast shaft, 7 feet diameter, has a ventilating furnace at the bottom, and contains a single winding apparatus. In a recess at the top of the second shaft, is fixed the air engine for working the winding and pumping apparatus of the second shaft. The compressed air is conveyed to it by a cast iron pipe, 10 inches diameter inside, carried down the main shaft, from a steam engine at the surface, which is employed to compress the air.

The steam cylinder is 15 inches diameter, with a stroke of 3 feet, and drives two condensing air pumps, which work alternately one on each side of the beam centre, delivering the air into the centre reservoir, from which it passes into the main pipe. The beam is connected at the other end to a crank and fly-wheel, to equalize the motion. The air pumps are 21 inches diameter, with a stroke of 18 inches; they are placed inverted, with the piston rods passing out below, where the stuffing boxes are not exposed to the pressure of the compressed air, and are worked with crossheads sliding in vertical guides by means of side rods from the beam. The air pumps are fitted with ball-valves, of which there are three sets to each pump, each set consisting of 44 brass balls, 2 inches diameter, arranged in three concentric rings. The balls are confined by separate cages to a lift of half an inch. In consequence of the high pressure of the air, amounting to 30 lbs. per square inch, provision is made for preventing leakage through the valves, by a stratum of water constantly covering the piston valves and the delivery and inlet valves, through which all the air has to pass. A small pump, 3 inches diameter and 10 inches stroke, is employed to supply water for this purpose, and delivers it into the centre reservoir, from which it flows through the small pipes, into each of the air pumps, during the period of their downward strokes, the quantity of water admitted being regulated by a cock in each pipe. The surplus water is discharged at each upward stroke through the delivery valves, and flows over the top into the centre reservoir, keeping the delivery valves also covered with water; in this way the compressed air is entirely discharged, and there is no loss of power from expansion of air behind the piston at the beginning of the downward stroke. The level of water in the centre reservoir, is regulated by means of a gauge glass at the side. Any leakage of water past the piston valves and piston, escapes through the suction or inlet valves, and is carried off by a waste pipe fitted to the casing of the air pumps.

The air pump barrels are lined with brass to prevent corrosion, and

the pistons are faced with brass and without packing, being merely turned a good fit to the cylinders. The pumps have continued working the whole time since starting, a period of more than six years, working part of the time day and night, without requiring any repairs or adjustment; nothing has been done to them, except replacing some of the valve cages which had been broken.

The usual speed of this engine is about 25 revolutions per minute, with a pressure of steam of 18 lbs. per square inch, giving a pressure of air averaging about 20 lbs. per square inch.

The air engine at the lower shaft has a cylinder 10 inches diameter and 18 inches stroke, and works usually at about 25 revolutions per minute; it is an old steam engine, and was formerly worked with high pressure steam. It was intended to be worked with air at 30 lbs. per square inch pressure, and at that pressure the heat generated in compression was expected to be very great; indeed, calculation at the time gave nearly the melting point of tin. The great safety valve, however, for getting rid of the heat developed, is, as was anticipated, the water upon the valves of the compressing engine, which absorbs the heat as soon as generated, a portion of the water passing off through the main pipe in the form of steam; this steam becomes condensed in the pipe, and provision is made for drawing off the water of condensation from time to time as it accumulates at the bottom of the shaft, by means of a cock.

The pressure of the air at the lower engine, is only about 1 lb. per square inch below the pressure of the compressing engine at the top of the pit. The absorption of heat on the sudden liberation of the compressed air from the lower engine, at the discharge of each stroke, causes so great a degree of cold, that in winter the engine is often stopped by the formation of ice in the cylinder and exhaust pipe.

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*On the Geology and Physical Geography of North America.** By Prof. Henry D. Rogers, from the United States.

(Continued from page 326.)

American Coal Fields.

The speaker selected from the many topics presented by this sketch of the geology of North America, that of the coal fields of the United States and British Provinces, as presenting a theme of general interest, describing first briefly the carboniferous formations, especially their coal measures.

This formation consists, in the United States and North-eastern British Provinces, of argillaceous and siliceous sandstones, conglomerates, clay shales, fire clays, and coal slates; argillaceous limestones, chiefly of marine origin, and seams of coal. A coarse siliceous conglomerate or millstone grit, generally destitute of coal, underlies the productive coal measures throughout nearly all the different basins, proving the universality of the action which attended the commencement of that state of

* Notices of the Meetings of the Royal Institution of Great Britain, Feb. 8th, 1856.

the physical geography that witnessed the production of the coal seams and the sediments which enclose them.

The eastern half of the continent exhibits five great coal fields, extending from Newfoundland to Arkansas. 1. The first, or most eastern, is that of the British Provinces, Newfoundland, Nova Scotia, Cape Breton, Prince Edward's Island, and New Brunswick. This seems to have been originally one wide coal field, subsequently broken up into patches by upheval and denudation, and by the submergence which formed the Gulf of St. Lawrence: the area of the coal measures of the provinces is probably about 9000 square miles, though only one-tenth of this surface appears to be underlaid by productive coal seams. 2. The second, or great Appalachian coal field, extends from North-eastern Pennsylvania to near Tuscaloosa, in the interior of Alabama. It is about 875 miles long, and 180 broad, where widest in Pennsylvania and Ohio, and by a careful estimate contains about 70,000 square miles. The narrow basins of anthracite in Eastern Pennsylvania, containing less than 300 square miles of coal, are outlying troughs from this great coal field. 3. A third, smaller coal field, occupies the centre of the state of Michigan, equidistant from Lake Huron and Michigan; it covers an area of about 15,000 square miles, but it is very poor in coal. 4. A fourth great coal field is that situated between the Ohio and Mississippi anticlinals, in the States of Kentucky, Indiana, and Illinois. It has the form of a wide elliptical basin. It is about 370 miles long, and 200 miles wide, and contains by estimation 50,000 square miles of coal measures. 5. The fifth, and most western, is the large and very long coal field filling the centre of the great basin of carboniferous rocks which spreads from the Mississippi and Ozark anticlinals, westward to the limit of the palæozoic region, where the cretaceous strata begin. The coal field itself has its northern limit on the Iowa River, and its southern near the Red River, on the western border of Arkansas. It is in length 650 miles, and in greatest breadth 200 miles. The total area of this great irregular basin is probably not less than 57,000 square miles. Three or more small detached tracts of coal strata, encompassed by the cretaceous deposits, stretch at intervals south-westward from the southern limit of the longer field through Texas. They are probably extensions of the great field laid bare by denudation. Other localities of coal bearing strata occur in the high table lands on both sides of the Rocky Mountains, and also in the Wahsatch chain of Utah, but it is doubtful whether any of them belong to the true carboniferous series. The aggregate space underlaid by these vast fields of coal amounts to at least 200,000 square miles, or to more than twenty times the area which includes all the known coal deposits of Europe, or indeed, of the whole eastern continent.

These coal fields, especially the four lying west of the Atlantic slope, exhibit several interesting facts of gradation, which render it highly probable that they were, at one time, all of them connected, the vacant intervals now separating them having been denuded of their coal measures by the wide-sweeping erosive action of the waters of the Appalachian Sea, set in motion by the uprising of this part of the continent. The

first fact of such gradation relates to the thickness of the formation, and that of the individual coal seams in the respective coal fields, the comparison indicating a marked reduction in this respect from east to west. Thus the productive coal measures of Nova Scotia have a thickness of nearly 3000 feet, those of the anthracite basins of Pennsylvania a depth about as great, while those in the central parts of the great Appalachian basin show a thickness not exceeding 2500 feet. Again, in the Illinois basin the probable thickness is reduced to 1500 feet, while in the farthest, or Ohio and Missouri basin, it cannot exceed 1000 feet. Very similar is the reduction in the number of the coal seams. Those at the Joggins, in Nova Scotia, are about 50; though only five of them are of workable dimensions, being equivalent to about 20 feet of coal. The deepest anthracite basin of Pennsylvania, that of the Schuylkill, contains also about 50 coal seams, but 25 of these have a thickness each of more than three feet, and are available for mining. Further west, the great Appalachian coal field contains about 20 beds in all, 10 of which are thick enough to be mined. Still farther onward, the broad basin of Indiana and Illinois shows apparently not more than 10 or 12 beds, and it is believed that only 7 of these are thick enough and pure enough for mining. Northward, in the Michigan coal field, denudation has left only the two or three lower beds. Still further westward the coal field of Iowa and Missouri contains, it is believed, but 3 or 4 beds of profitable size, and the total number, thick and thin, does not exceed 6 or 7. A similar gradation is noticeable in the general size of the individual coal seams, by far the thickest being in the anthracite basins of Eastern Pennsylvania.

Parallel with this progressive reduction in the amount of land-derived material in the upper coal formation, is a diminution in the coarseness of the mechanical ingredients of the strata, the eastern coal measures having more conglomerates and coarse sandstones, the western, more fine-grained argillaceous sandstones and clay beds; and as a further indication that the first land lay to the east and the ocean to the west, of the wide coal-producing plains or meadows, there is with this westward reduction of the mechanically derived sediments from the land, a steady augmentation of marine limestones, and other true aqueous deposits, precipitates of a shallow carboniferous sea. In some of the more western coal fields the alternation of the terrestrial coal seams with super-imposed limestones, containing marine fossils, amounts even to an occasional actual contact of the two kinds of strata.

Apart from these general phenomena of gradation which belong to the conditions under which the strata originated, there exist other facts of transition, which also imply a declension westward, of quite another class of forces than the productive ones. In the Appalachian chain, all the eastern coal basins, and the eastern margin of the great Appalachian field, give evidence of a crust metamorphism, affecting all the palæozoic rocks, the degree of alteration dependent on the nature of the stratum, and its situation, eastward or westward, in this great undulated zone. The coal, of all rocks the most sensitive to metamorphism from heat, presents invariably among the eastern flexures of the Appalachians, where the crust action has been greatest, the condition of a hard and flinty anthracite with a jaspery or large conchoidal fracture; further westward

in the same set of basins, the anthracite has a more cuboidal fracture, is softer, and is even slightly gaseous. Entering the eastern border of the great Appalachian bituminous coal field, we everywhere find the coal possessed of only half its full share of volatile or gaseous matter; and it is not until we reach the middle and western side of this wide basin, that the coal is found fully bituminous,—in other words, not until we pass beyond the last of the perceptible undulations of the crust. Throughout all the flat fields of the Western States, the coal invariably retains its original full amount of bituminous or gaseous ingredients.

Comparing the areas of the coal fields of other countries with those of North America now indicated, Great Britain may be estimated to contain about 5400 square miles, France 1000, and Belgium 510 square miles. Rhenish Prussia—Saarbrook field—has 960 square miles, Westphalia 380, the Bohemian field, about 400; that of Saxony, only 30; that of the Asturias, in Spain, probably 200; and that of Russia, scarcely 100 square miles. And as these are the principal known coal fields in Europe, the whole is thus seen to possess less than 9000 square miles of productive coal measures. Comparing the coal areas with the total areas of the respective countries, the United States has one square mile of coal field to each 15 square miles of its 3,000,000 miles of territory; Great Britain has one square mile to each 22½ of surface; Belgium a like proportion; while France possesses only one square mile of coal field to every 200 miles of country. Assuming the total area of the productive coal measures of the world at 220,000 square miles, and accepting 20 feet as the average thickness of the available coal, the entire quantity, if estimated as one lump, is equivalent to a cube of very nearly 10 miles dimensions, or equivalent to a cake or plateau of coal 100 miles square in its base, and 440 feet high.

The present annual product of the chief coal producing countries is as follows:—Great Britain extracted from her coal mines last year—1855—the enormous quantity of 65,000,000 tons; the United States, between 8 and 9,000,000; Belgium, about 5,000,000; and France, 4,500,000.

It is interesting to compare the dynamic force of coal applied as fuel to the generation of steam in the steam engine, with the dynamic effect of a man. The human laborer, exerting his strength upon a treadmill, can raise his own weight, say 150 lbs., through a height of 10,000 feet per day, equivalent to 1 lb. raised 1,500,000 ft. The mechanical virtue of fuel is best estimated by ascertaining the number of pounds which a given quantity, say one bushel, will raise to a given height, say one foot, against gravity. In the steam engine this is called the *duty of the fuel*. Now, the present maximum duty of one bushel of good coal in the improved Cornish steam engines, is equivalent to 100,000,000 lbs. lifted through one foot; but one bushel has been made to raise 125,000,000 lbs. one foot high, or one pound 125,000,000 of feet; but as there are 84 lbs. in one bushel, this divisor gives one pound as equal to 1,500,000 ft.; just the result of a man's toil for one day upon a treadmill. Thus a pound of coal is really worth a day's wages. If we estimate a lifetime of hard work at 20 years, giving to each year 300 working days, we have for a man's total dynamic effort 6000 days. In coal this is repre-

sented by the amazingly small amount of *three tons.* Another proof of the extraordinary power derivable through the combustion of fuel, is presented in the following calculation; one cubic inch of water is convertible into steam, of one atmospheric pressure, by 15¼ grains of coal, and this expansion of the water into steam is capable of raising a weight of one ton the height of a foot. The one cubic inch of water becomes very nearly one cubic foot of steam, or 1728 cubic inches. When a vacuum is produced by the condensation of this steam, a piston of one square inch surface, that may have been lifted 1728 inches, or 144 feet, will fall with a velocity of a heavy body rushing by gravity through one-half of the height of the homogeneous atmosphere, or through 13,500 feet. This gives a terminal velocity of 1300 feet per second, greater than that of the transmission of sound. From this we can form some estimate of the strength of the tempest which alternately blows the piston in its cylinder, when elastic steam of high pressure is employed. Applying the calculations of the dynamic efficiency of coal, for estimating the mechanical strength latent in the coal fields of the earth, or in the large coal product annually furnished by the mines of Great Britain, we get some interesting results. Each acre of a coal seam, four feet in thickness, and yielding one yard nett of pure fuel, is equivalent to about 5000 tons; and possesses, therefore, a reserve of mechanical strength in its fuel equal to the life-labor of more than 1600 men. Each square mile of one such single coal bed contains 3,000,000 of tons of fuel: equivalent to 1,000,000 of men laboring through twenty years of their ripe strength. Assuming, for calculation, that 10,000,000 of tons, out of the present annual product of the British coal mines, namely 65,000,000, are applied to the production of mechanical power, then England annually summons to her aid an army of 3,300,000 fresh men, pledged to exert their fullest strength through 20 years. Her actual annual expenditure of power, then, is represented by 66,000,000 of able-bodied laborers. The latent strength resident in the whole coal product of the kingdom may, by the same process, be calculated at more than 400,000,000 of strong men, or more than double the number of the adult males now upon the globe.

Climates.—Adverting to the causes of the characteristic features of the North American climates, those of all the eastern and northern divisions of the continent were shown to depend primarily upon the peculiar distribution of the land and water, and the general circulation of the winds and oceanic currents in the North Atlantic and the Polar Basins, resulting from general phenomena of rotation of the fluids, and from the configuration of those seas. The chief surface currents of both these basins belong all to one great circulating stream, which, crossing the Atlantic from Africa to the Gulf of Mexico, under the northern tropic, and following for a vast distance the highly-heated shores of South and Central America, enters the North Atlantic at Florida, under the name of the Gulf Stream, carrying a temperature of 5° to 6° higher than the mean heat of the equator, and imparting to the southern coast of the United States the ocean temperature of the tropics. Pursuing its career to the north-east, this current transports its own mild

climate to the whole north-western side of Europe, and even subdues the rigors of the European Polar Sea; but refrigerated, as it sweeps round in its circumpolar course, the shores of Siberia and Western Arctic America; and, loaded with the annual ice of all that extended zone, it streams through the great Archipelago of North-eastern Arctic America, clogs its deep channels with its floating packs of ice, and chills to the zero temperature of the whole hemisphere this coldest of all the summer climates of the globe. Returning into the Atlantic around Greenland, and by its main passage through Baffin's Bay, this now Arctic ice-chilled and ice-transporting current, hugs the whole north-eastern coast of the continent inside of the Gulf Stream. It thus weaves a track somewhat resembling the figure 8. The Gulf Stream on the south-east, and the Arctic current on the north, conjointly with the tropical and the polar winds with which they are connected, produce such a contrast in the temperature of the southern and northern latitudes of eastern America, that all the zones of the climates of the sphere are there compressed within not more than 30° of a great circle, crossing the continent from the Gulf Stream to lat. 70° north of Hudson Bay.

The climatology of the western half of the continent was next discussed. There the controlling agent in the latitudes north of the north-east Trade Wind of the tropic, is the south-west and west wind from the Pacific Ocean, and in the Southern Atlantic States from the Gulf of Mexico. This Pacific Ocean wind, moderately charged with moisture in the lower latitudes, and excessively humid in the more northern ones from traversing a wider tract of sea, confers a temperate, moist, and oceanic climate upon the Pacific slope; but deprived largely of its moisture by ascending the high mountain barrier of the Pacific chain, which robs it of nearly the whole of its wetness, it exerts in the more southern latitudes just the opposite effect upon the plains and table lands to the leeward or eastward of that barrier. The high evaporative power of the winds thus parched accounts for the excessive aridity of the Colorado and Utah deserts, and the whole desert belt of the interior which in the lower latitudes stretches to Texas. It likewise explains the prevalence of numerous salt lakes, destitute of outlets, and the occurrence of the wide tracks covered with salt, or with a saline soil, within this area.

Gold.—To the same general cause, the Pacific wind, we are to attribute the abundant gold alluvia of the western slope and base of the Sierra Nevada. The copious precipitation of rain, amounting to nearly the whole humidity of the Pacific wind, against the gold containing western flank of the Californian chain, greater probably in the pleistocene than in the modern epochs, has produced an enormous erosion of the gold-bearing and cleavage fissured rocks; and has strewn and sorted their fragments and particles in the ravines of the mountain, and in the plains at its base. The speaker concluded with an announcement of the general fact that, whereas the salt fields of the earth are found upon the continental or interior dry sides of its oceanic chains, its gold fields are restricted to their wet or oceanic slopes.

*Atlantic Telegraph Cable.**

We have been favored by the contractors for the Atlantic telegraph, with a piece of the cable for the deep sea. This cable consists of a central copper strand of seven small copper wires of No. 22 gauge, acting as the conductor through which the signals are to be transmitted. Owing to the retardation which experiment has disclosed to exist in large wires, these small wires are found necessary. Each or all seven together act as a conductor. The strand of the seven copper wires, about one-tenth of an inch in the cable diameter, is surrounded with a coating of gutta percha, averaging about 0·15 inch thick. This gutta percha is again closely and tightly covered with 18 strands each, consisting of 7 iron wires, the object of which is to protect and keep close the gutta percha round the conducting strand of copper, and to give strength to the cable. To prevent the oxidation of the iron wire under water, which unprotected would be rapid, a mixed solution of Stockholm tar and pitch, well rubbed in, coats the iron strands.

From the specimen before us, the cable is exceedingly well made, and though compact and strong, is sufficiently flexible. Its weight is 19 cwt. to a mile, and Messrs. Kuper & Co., who have 1260 miles to make in one length, and to lay in the Atlantic, are to have it on board ship by the end of next June. The other portion of the cable is making in America, and will start about the same time from the American side, to meet midway the vessel carrying the English portion of the cable.

A sort of plateau of sand has been discovered running across the Atlantic on which the cable is to be laid. The greatest depth by soundings appears to be 2070 fathoms, giving a pressure of water per square inch of 6210 lbs., or nearly three tons.

Two causes of apprehension existed with regard to the success of a telegraphic communication across the Atlantic. One was that the great pressure of water would penetrate any supposed insulation of the conducting wires, and consequently disperse or so weaken the magneticoelectric current as to prevent the action of the needle on the other side, or it might so change the molecular arrangement of the copper particles as to materially interfere with, if not destroy, the transmission of the signals. Mr. Glass, however, informs us, that a pressure of four tons to the square inch has been used on the cable, and no sensible disturbance produced, which of course disperses to the winds the first apprehension.

The second apprehension arose from an experimental fact, on the Anglo-Belgian submarine cable, that the signals transmitted through a cable submerged to any depth suffered a very sensible retardation and lingering, in only about 300 miles. From this fact it was therefore feared that in a cable of ten times the length, exposed to much greater depths and pressures, the definition of the signals, if they should ever reach the opposite shores, would be so feeble and imperfect as to be unintelligible, and so slow in their transit as to be comparatively useless. Mr. Whitehouse, however, the engineer of the Company, has, by sending alternately positive and negative currents, obviated greatly, if not wholly, this difficulty, increased the number of the repetitions of signals,

* From Herapath's Journal, No. 923.

and sharpened their definition. He seems to think that the alteration of opposite currents clears out the wire from any lingering remains of the preceding signal. Whether this be so or not, if the lingering action be destroyed, a greater number of signals can be transmitted, and the grand desideratum of the telegraph—instantaneous transmission—be more nearly approximated.

Our government, it is known, proposes to allow the Company £14,000 a year for such use of the telegraph as it may require. The American government is said to have consented to allow an equal sum, which together, will give 9½ per cent. on the estimate of £300,000.

For the Journal of the Franklin Institute.

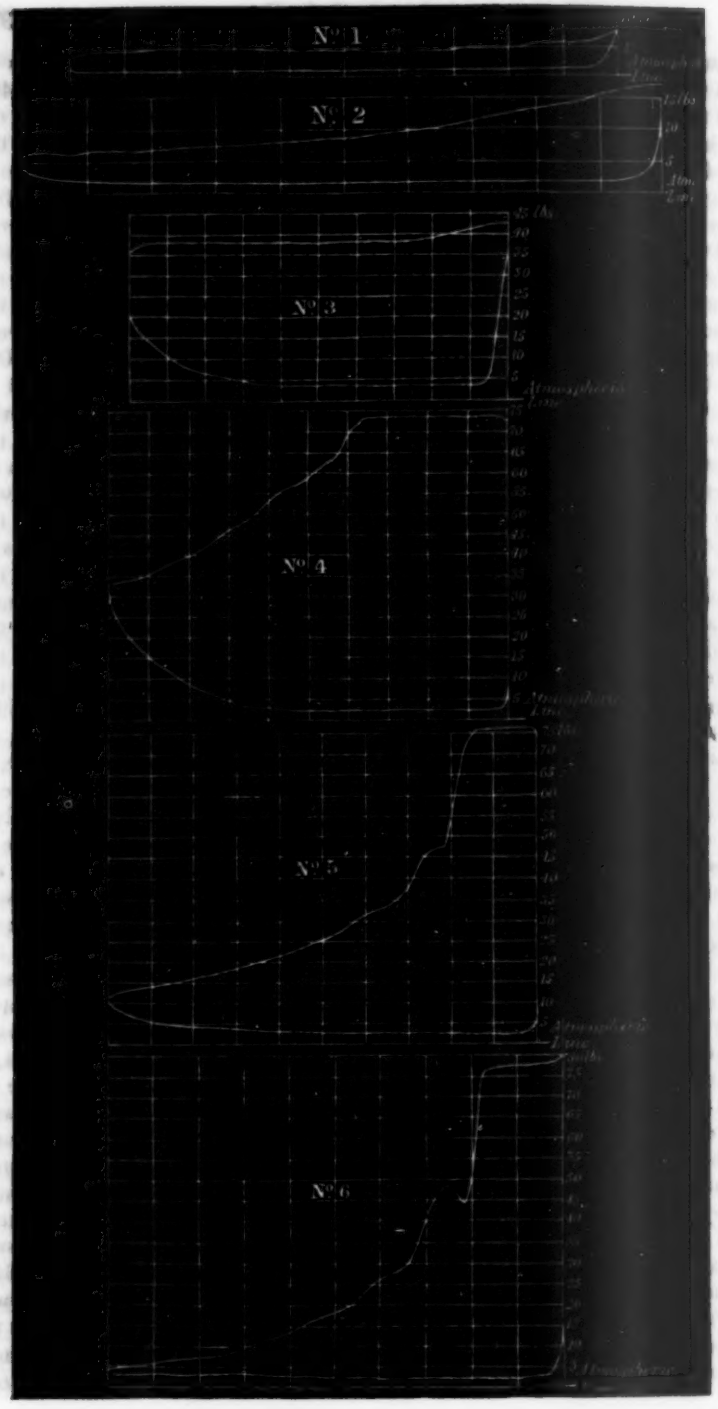
Experiments made at the Steam Flour Mills of Messrs. Hecker & Brother, New York. By Chief Engineer, B. F. Isherwood, U. S. Navy.

(Continued from page 309.)

With regard to the back pressure on the pistons, it will be observed, that, excepting series D and F, it steadily increased with the increase of the final pressure at the end of the stroke of piston, ranging from 1·65 to 5·00 pounds per square inch above the atmosphere, for final pressures of from 3·60 to 30·68 pounds per square inch above the atmosphere. The area for the exhaust is really the same as for the steam, though the exhaust port itself is larger, because the exhaust steam must first pass through the steam port before it can enter the exhaust port; and from the foregoing it will be seen, that this area was too small when any considerable quantity of steam was exhausted through it. There is also another fact to be prominently noted in this connexion; it is that although the surface condenser condensed *all* the exhaust steam, yet in no case, not even when using the small amount of steam required to work the engine and shafting *per se* at the slowest speed, did the back pressure fall to less than one pound per square inch above the atmosphere. At this time and for the purpose of testing this point of minimum possible back pressure, the surface condenser was flooded by the independent steam pump with a copious supply of water, but little above the freezing point. There was particular attention paid to this fact, because it is a common though very erroneous opinion among a large number of engineers, that with non-condensing engines exhausting through a "heater," which, to a certain degree, acts as a surface condenser, it is possible to reduce the back pressure below the atmosphere. This opinion is very prevalent on the Western rivers where such engines are wholly used, and although such a result is manifestly impossible, as it involves a contradiction to the best established law of physics, viz: the equality of pressure and resistance, yet as it was held by many practical men it was thought as well to practically refute it.

An inspection of the columns headed "Relative Economy of Fuel," will show, in a striking manner, the immense influence exerted on the economical result by the "Ratio of the back Pressure to the total Average Pressure." For instance, comparing Series A and B, whose points of cutting off, and whose actual coefficients of the expansion of the steam are substantially the same, but whose ratio of the total back pressure to the

total average pressure vary as 0·478 and 0·591, leaving with Series A, (1·000—0·478 =) 0·522, and with Series B, (1·000—0·591 =) 0·409 of the pressure to be applied to the development of power; we have the relative economy of fuel as 1·923 to 2·536 or as 1·000 to 1·319; but 0·409 and 0·522 compare as 1·000 to 1·276, or nearly the same; showing that the great difference of 32 per centum in the consumption of fuel for equal powers in the two cases, was caused entirely by the difference of the ratios of the back pressure to the average total pressure. Again, if we compare Series C and G, in which the points of cutting off are respectively 0·348 and 0·237 of the stroke; but in which the ratios of the back pressures to the total average pressures are 0·280 and 0·340, leaving with Series C (1·000—0·280 =) 0·720, and with Series G, (1·000 —0·340 =) 0·660 of the pressure to be applied to the development of power, we find, that notwithstanding the greater economy to be derived from cutting off shorter in Series G, yet the economical result with the fuel was precisely the same in both cases, owing to the fact, that with Series G, the ratio of the back pressure to the total average pressure was so much higher than in Series C, as to exactly balance the gain by the greater expansion. Once more, if we compare Series E with Series I, we shall find the economy of fuel to be greater with E than with I in the ratio of 1·257 to 1·358, although the point of cutting off with the former was 0·298, and with the latter 0·152 of the stroke, the difference of the gain by the greater expansion being overbalanced by the loss from the greater ratio of the back pressure. In these cases the proportion of the pressure applied to the development of power was with Series E 0·699, and with series I 0·635. In making these comparisons throughout all the Series, some discrepancies will be observed; they are to be referred to the leakage of a cut-off valve already noticed, and went of course to vitiate the rate of expansion as given by the actual closing of the valve. From the foregoing, will be appreciated how great is the importance in view, not only of economical but of potential results, to make the exhaustion as low as possible, and to reduce the ratio of the back pressure to the total average pressure to a minimum, by using the highest convenient average pressure throughout the stroke. It shows how easily the gain by cutting off the steam shorter, which with the same initial pressure will give a less average pressure throughout the stroke, can be neutralized by the loss consequent on the necessarily increased ratio of the back pressure, and that to *fully* realize the benefits of increased expansion, it must be accompanied by a corresponding increased initial pressure so as to maintain the same average pressure as before. These remarks are particularly applicable to non-condensing engines, where the atmospheric pressure alone constitutes with any practicable initial steam pressure, a very high ratio of back pressure. A point can soon be reached, beyond which, if expansion be carried, a loss in economy of fuel instead of gain will result; as for example, in Series C and I, both having substantially the same initial steam pressure, by cutting it off in C at 0·348, and in I at 0·152 of the stroke; in these Series the economy of fuel was 1·234 for the long, and 1·358 for the short cut-off, showing that the greater expansion resulted in a greater loss from the causes just mentioned. Practically, economy of fuel depends conjointly on the ratio of


N° 1
N° 2
N° 3
N° 4
N° 5
N° 6

the expansion of the steam and on the ratio of the back pressure to the total average pressure.

Indicator Diagrams.

A few specimens of the Indicator Diagrams taken, will be satisfactory to the reader; the following are therefore given, viz:—

No. 1 was taken when the power was employed merely to overcome the friction of the engines and shafting. Number of double strokes of pistons made per minute 18.

No. 2 was taken under precisely the same circumstances as No. 1, except that the steam was entirely shut off from one cylinder, the other cylinder only being used. The number of double strokes of piston made per minute was 36, and the mean effective pressure throughout the stroke is just double that of No. 1.

No. 3 was taken before the old throttle valve was removed; all the valves except the cut-off, which was fastened wide open, were in the same condition as when the diagrams for Series A, B, and F were taken. Steam pressure in boilers, 85 pounds per square inch. Number of double strokes of pistons made per minute was 36.

No. 4 is one of the diagrams taken for Series C.

" 5 " " " I.

" 6 " " " J.

and after the last cut-off had been substituted for the first one.

Evaporation by the Boilers.

The evaporation was carefully ascertained in the following manner, viz:—The water in the boilers being at its normal height, was heated until the gauge showed a steam pressure of 85 pounds per square inch above the atmosphere; the fire was then withdrawn from the furnace, and a new fire started with the Lackawana anthracite of the nut size, the lumps averaging about an inch cube; 6000 pounds of this coal were accurately weighed out and regularly fed to the furnace; the fire was managed by the regular fireman exactly the same as in ordinary practice. The coal was entirely consumed in 10 hours 30 minutes, when the remaining ashes, clinkers, and unburnt coal were weighed. The chimney damper was kept wide open. The boilers had been in constant use for several days previous, and the brick-work was thoroughly dry and heated up. The weather was clear, fine, and dry, the thermometer averaging 30° Fah. The boiler pressure was very regularly maintained, the minimum being 78 and the maximum 90 pounds per square inch above the atmosphere. The number of double strokes made per minute by the pistons was very regular throughout the experiment, the minimum being 36 and the maximum 39. The pressure in the cylinders before cutting off was 63 pounds per square inch above the atmosphere for the minimum, and 70 for the maximum. The work performed was grinding with three run of four feet diameter stones, 50·75 bushels of wheat per hour.

The Worthington steam pump for supplying cold condensing water to the condenser, averaged during the experiment 78 double strokes of piston per minute, its throttle being nearly closed. The diameter of the steam cylinder of the pump is 12 inches, stroke of piston 7 inches. Space displacement of piston per stroke, plus clearance and

nozzles, 0·48 cubic foot. The final steam pressure in this cylinder averaged, by experiment at the end of the stroke, as nearly as could be ascertained, 24 pounds per square inch, including the atmosphere. The steam used in the Worthington pump will be computed separately.

The temperature of the water overflowing from the condenser averaged 80° Fah. The temperature of the water of condensation in the reservoir averaged 130° Fah. The temperature of the feed water when fed into the boilers averaged 122° Fah. The temperature of the condensing water was 36° Fah.

Indicator diagrams were taken regularly every 20 minutes during the experiment, and the quantity of steam used is computed from the average of the final pressures in the cylinders at the end of the stroke. Each diagram was traced three times by the pencil, and all not agreeing were rejected and new ones taken. The following are the data and results:

Data.

Total duration of the experiment in hours and minutes,	10h. 30′
Total number of double strokes of piston made by the engines,	23,310
" " Worthington's steam pump,	49,140
Total number of pounds of Lackawana anthracite, lumps 1 inch cube, put in the furnace,	6000
Total number of pounds of ashes, clinkers, and unburnt coal withdrawn from the furnace,	1020
Total number of pounds of combustible consumed,	4980
Average steam pressure in boilers in pounds per square inch above the atmosphere,	81
Average steam pressure in cylinders in pounds per square inch above the atmosphere, before cutting off,	66
Average steam pressure in cylinders in pounds per square inch above the atmosphere at end of stroke of pistons,	15·8
Steam cut-off at in cylinders from commencement of stroke of pistons, 0·203 or 9·744 ins.	
Mean number of double strokes of piston made per minute by engines,	37
Mean number of double strokes of pistons made per minute by the Worthington steam pump,	78
Average steam pressure in the steam cylinder of the Worthington pump at end of stroke of piston in pounds per square inch, including the atmosphere,	24
Mean number of pounds of coal thrown on the grate per hour,	571
" " combustible consumed "	474
Mean temperature of the water fed into the boilers, in degrees Fah.,	122°
Mean temperature of the heated gases escaping from the boilers, in degrees Fahrenheit,	694°
Mean temperature of the heated gases in the furnace and over the incandescent fuel, in degrees Fah.,	1750°

Results.

Total number of cubic feet of steam of atmospheric pressure consumed by the engines,	913789·800
Total number of cubic feet of steam of atmospheric pressure consumed by the Worthington steam pump,	73982·000
Total number of cubic feet of steam of atmospheric pressure consumed during the experiment,	987771·800
Number of pounds of steam evaporated by one pound of coal, temperature of feed water 122° Fah.,	6·052
Number of pounds of steam evaporated by one pound of coal, temperature of feed water 100° Fah.,	5·925
Number of pounds of steam evaporated by one pound of coal, temperature of feed water 212° Fah.,	6·635

Number of pounds of steam evaporated by one pound of combustible, temperature of feed water 122° Fah.,	7·291
Number of pounds of steam evaporated by one pound of combustible, temperature of feed water 100° Fah.,	7·138
Number of pounds of steam evaporated by one pound of combustible, temperature of feed water 212° Fah.,	7·994
Number of pounds of coal consumed per hour per square foot of grate surface,	9·930
Number of pounds of combustible consumed per hour per square foot of grate surface,	8·244
Number of pounds of coal consumed per hour per square foot of heating surface,	0·489
Number of pounds of combustible consumed per hour per square foot of heating surface,	0·405
Number of pounds of steam evaporated per hour from one square foot of heating surface,	2·959
Number of square inches of air space in the grate per pound of coal consumed per hour,	3·410
Number of square inches of air space in the grate per pound of combustible consumed per hour,	4·110
Number of square inches of cross area of the flues per pound of coal consumed per hour,	1·190
Number of square inches of cross area of the flues per pound of combustible consumed per hour,	1·430

The above experiment was, for the purpose of confirmation, continued by the consumption of 4000 pounds more of the same coal accurately weighed and regularly fed to the furnace as before. The cut-off was altered so as to cut off shorter, carry a higher pressure, and maintain about the same number of double strokes of piston per minute as before. The temperatures of the feed, condensing and overflow water remained as before; also, the number of double strokes made per minute by the steam piston of the Worthington pump, and the quantity of steam required to supply it. The temperatures of the heated gases in the furnace, and escaping from the boiler, were the same as before. The number of pounds of coal thrown on the grate per hour was the same precisely as before; and this coal, being the same, left precisely the same per centage of ashes, clinker, and unburnt coal. The minimum boiler pressure was 85, and the maximum 102 pounds per square inch above the atmosphere. The steam pressure in the cylinders before cutting off was for minimum 68, and for maximum 80 pounds per square inch above the atmosphere. The minimum number of double strokes of piston made per minute was 38, and the maximum 40. The chimney damper was carried wide open. The duration of the experiment was 7 hours 10 minutes. The work done consisted in grinding wheat with four run of 4 feet diameter stones, at the rate of 46 bushels per hour, the feed on each run of stone having been made considerably lighter than before. Indicator diagrams were taken every 15 minutes, and the quantity of steam used is computed, as in the first experiment, from the average of the final pressures in the cylinders at the end of the stroke of the pistons. Each diagram was thrice traced by the pencil. If the three tracings did not coincide, it was rejected and a new one taken. The steam consumed by the Worthington pump is computed separately and added. The following are the data and results of this the second experiment, to determine the evaporation by the boilers, viz :—

Data.

Total duration of the experiment in hours and minutes,	7h. 10′
Total number of double strokes of piston made by the engines,	16,598
" " " " Worthington steam pump,	33,540
Total number of pounds of Lackawana anthracite, lumps 1 inch cube, put in the furnace,	4000
Total number of pounds of ashes, clinkers, and unburnt coal withdrawn from the furnace,	680
Total number of pounds of combustible consumed,	3320
Average steam pressure in boilers in pounds per square inch above the atmosphere,	91
Average steam pressure in cylinders in pounds per square inch above the atmosphere before cutting off,	72
Average steam pressure in cylinders in pounds per square inch above the atmosphere at end of stroke of pistons,	13·3
Steam cut off at in cylinders from commencement of stroke of pistons,	0·152 or 7·296 in.
Mean number of double strokes of piston made per minute by engines,	38·6
" " " " " the Worthington steam pump,	78
Average steam pressure in the steam cylinder of the Worthington pump at end of stroke of piston in pounds per square inch, including the atmosphere,	24

Results.

Total number of cubic feet of steam of atmospheric pressure consumed by the engines,	601574·300
Total number of cubic feet of steam of atmospheric pressure consumed by the Worthington steam pump,	50495·800
Total number of cubic feet of steam of atmospheric pressure consumed during the experiment,	652070·100
Number of pounds of steam evaporated by one pound of coal, temperature of feed water 122° Fah.,	5·993
Number of pounds of steam evaporated by one pound of coal, temperature of feed water 100° Fah.,	5·867
Number of pounds of steam evaporated by one pound of coal, temperature of feed water 212° Fah.,	6·570
Number of pounds of steam evaporated by one pound of combustible, temperature of feed water 122° Fah.,	7·220
Number of pounds of steam evaporated by one pound of combustible, temperature of feed water 100° Fah.,	7·069
Number of pounds of steam evaporated by one pound of combustible, temperature of feed water 212° Fah.,	7·915
Number of pounds of steam evaporated per hour from one square foot of heating surface,	2·861

These results are almost identical with those from the first experiment.

The steam room of the boilers contains 442 cubic feet, and when cutting off at the longest, there was drawn from it only 4 cubic feet of steam per stroke of pistons, or about the 110th part; consequently there could have been but little loss from foaming, especially as the steam was taken out at a height of 6 feet 9 inches above the water level. The covering of the boilers, steam drums, and steam pipes, was so complete that no great loss from radiation could have taken place; this loss could have been sensible from the uncovered cylinders only.

I consider these boilers a very good specimen of their type; they are of sufficient length to retain the heated gases within them for a reasonable time. These gases are first broken up and mixed at the cross boiler, and again when they enter the return flues. The brick bridge walls are

judiciously shaped, and the calorimeter well proportioned. The air spaces between the grate bars, and the grate bars are very narrow; the amount of coal burned per square foot of grate per hour is moderate, and the ratio of the heating to the grate surface, without being large, is considerable. In view of all the above conditions, I am disposed to consider the evaporation obtained as a maximum for this type of boiler.

I endeavored to obtain the temperature of the heated gases at their exit from the flues, but a mercurial thermometer graduated to 570° Fah., which was used for that purpose, broke by the expansion of the mercury within, after it had reached that temperature. I now resorted to sheet lead, and placed at the mouth of the flues a small roll of that metal supported on a fire brick; it melted at once and ran down like water; this experiment, repeated a number of times, at intervals, and with different flues, gave always the same result. I then tried zinc in the same manner; this metal was not in the least fused by the heat, the edges and filaments of the fractured parts remaining as sharp and distinct as when first placed at the mouth of the flue. I now placed, immediately after a fresh charge of coal had been thrown on the grates, a roll of sheet lead having a portion cut into fine fragments at the junction of the sheet iron conduit and the brick chimney; this conduit is 10 feet long, and connects the mouths of the flues with the chimney. The fine fragments of lead soon fused and ran together, but the large mass of the lead did not thoroughly melt until the fires were at their maximum. The melting point of lead is, according to Morveau, 593°·6 Fah.; according to Dalton 611°·6 Fah.; according to Rudburg 617° Fah., and according to Kupffer 633°·2 Fah.; the mean of these authorities is 614° Fah. The melting point of zinc is, according to the accurate experiments of Daniell, 774° Fah. The temperature of the heated gases at their exit from the flues lay, therefore, between these numbers; perhaps we shall nearly approach the truth by the mean, and may consider the temperature to have been

$$\left(\frac{614+774}{2} =\right) 694° \text{ Fah.}$$

I endeavored to obtain the temperature of the heated gases in the furnace immediately over the incandescent fuel, in the following manner, viz: I took a thin round piece of silver and bent it nearly double, and placed it on a fire brick so that it touched the brick but at two points, and exposed both sides of the silver to the action of the heat. The furnace having been freshly fired-up, the brick with the silver on it was placed in the centre, and at about one-third the length of the furnace from the bridge wall; it was allowed to remain a considerable time, and until the furnace required firing again, when it was withdrawn, and was found to be sunk down flat and fused on the surface, but not thoroughly melted throughout. A roll of fine copper wire was next tried in the same manner, but on being withdrawn after a considerable time exhibited no marks of fusion. The melting point of silver is, according to Prinsep, 1830°·2 Fah.; according to Pouillet, 1832° Fah.; and according to Morveau, 1893°·2 Fah.; the mean of these numbers is 1852° Fah., and as the temperature of a steam boiler furnace fluctuates about 200° Fah., we shall probably be not far from the truth if we take 1750° Fah. for the mean temperature of the furnace.

In the September number of this *Journal*, 1854, pages 196 and 197, it has been shown by the writer, that the heating power of coal is practically in the direct ratio of the carbon they contain; and that the total theoretical evaporation possible by one pound of carbon, supposing no heat to be lost by radiation, or in producing the draft, or in any other manner, and that the entire amount of heat developed by the combustion was applied to the evaporation, is 14·624 pounds of water from the temperature of 212° Fah. Also, that the composition of Pennsylvania anthracite is, according to the ultimate analysis of Richardson, and exclusive of earthy matter, as follows, viz: oxygen, 2·56 per centum; hydrogen, 2·55 per centum; and carbon, 94·89 per centum. Hence, the absolute theoretic evaporation by our coal will be $(14{\cdot}624 \times 0{\cdot}9489 =)$ 13·877 pounds of water per pound of coal consumed after deducting the ashes, clinkers, &c. Now, the coal consumed in the experiments, after deducting ashes, clinkers, &c., evaporated per pound 7·994 and 7·916, mean 7·955 pounds of water from 212° Fah., leaving $(13{\cdot}877 - 7{\cdot}955 =)$ 5·922 pounds to be accounted for. The temperature of the heated gases when in the furnace being 1750° Fah., and when leaving the boiler 694° Fah., there would be expended in producing the draft $\left(\frac{694 \times 100}{1750} =\right)$ 39·66 per centum of the total heat, equivalent to an evaporation of $(13{\cdot}877 \times 0{\cdot}3966 =)$ 5·504 pounds of water from 212° Fah., leaving $(5{\cdot}922 - 5{\cdot}504 =)$ 0·418 pounds for radiation, &c.

When the quantity of air entering the furnaces, the composition of the coal, and the temperature of the heated gases escaping from the boiler are known, the per centage of the total heat developed by the combustion, which is lost by the heated gases passing into the chimney and producing the draft, can be calculated. That loss varies not only with the temperature of the escaping heated gases, but also with the *quantity of air entering the furnace.* Let us take the case where only the exact quantity of atmospheric air enters the furnace, which is required for the perfect combustion of the coal of our experiments. Referring again to page 197 of the September, 1854, number of this *Journal*, it is there shown that the total calorific power of 1·00 unit of weight of carbon—the sole heat-producing constituent—is capable of heating 75·094 units of weight of water from the freezing to the boiling point, or of giving out $(75{\cdot}094 \times (212 - 32) =)$ 13668 units of heat. The products of the combustion of one pound of our coal, after deducting ashes and clinkers, amount to 12·8 pounds of gases, the mean density of which differs but little from that of atmospheric air. The specific heat of this mixture of gases is also about that of the atmospheric air, and the specific heat of the latter is one-fourth that of water; consequently one pound of carbon will raise one pound of the gases through $(13668 \times 4 =)$ 54672° Fah.; but this heat if diffused among 12·8 pounds, the temperature will therefore be $\left(\frac{54672}{12{\cdot}8} =\right)$ 4271° Fah. This, however, is on the supposition that no more air has entered the furnace than is rigorously required for the combustion; if a greater weight of air enter, the temperature will of course be reduced in that proportion. Now we have seen

that the temperature of our furnace was experimentally 1750° Fah., therefore the weight of gases passing from the furnace was $\left(\frac{4271}{1750} = \right) 2{\cdot}44$ times greater than it should have been, or instead of being 12·8 pounds it was (12·8×2·44=) 31·23 pounds, of which the original fuel constituted one pound, leaving 30·23 pounds of atmospheric air to have entered instead of (12·8—1·0=) 11·8 pounds, or $\left(\frac{30{\cdot}23}{11{\cdot}8} = \right)$ 2·56 times more air than necessary. The 2·56 times more air than what was rigorously required for combustion, which passed through the grates, shows there was no lack of oxygen to render the combustion perfect; it also shows that the grate surface was too large for obtaining the highest economical result from the fuel, because with the given draft and weight of coal consumed, it admitted 2·56 times more air than necessary, and involved a loss of caloric represented by this weight of air multiplied by the difference of its temperature when entering and leaving the boiler. The fuel was kept about 7 inches thick on the grates; now had the latter been reduced from 5 to 3 feet in length, and the fuel kept about 12 inches deep on the grates, it is evident that a considerably higher economical result would have been attained, and that about the same weight of fuel would have been consumed as before. It is a fact well known to engineers, that a reduction of grate surface in a given boiler is very frequently productive of the most satisfactory results. This will particularly follow in boilers where a strong draft obtained by height of chimney is joined to a moderate consumption of coal per square foot of grates per hour. Had no more air entered the furnace than what was rigorously required for the combustion of the fuel, and supposing also the combustion to have been perfect, the loss of heat by the gases entering the chimney at 694° Fah., would have been only $\left(\frac{694\times100}{4271} = \right)$ 16·25 per centum, instead of 39·66 per centum, as was actually the fact.

From the foregoing data, the velocity with which the heated gases leave the furnace can be computed. These gases have about the same mean density as dry atmospheric air, which weighs 0·076555 pounds avoirdupois per cubic foot at the standard of 60° Fah., and 30 inches barometer. There was consumed of combustible during the experiment 474 pounds per hour, and we have seen that the products of the combustion and the additional air which entered the furnace, amounted to 31·23 pounds per pound of combustible, or to $\left(\frac{31{\cdot}23\times474}{60} = \right)$ 246·717 pounds per minute, equal to $\left(\frac{246{\cdot}717}{0{\cdot}076555} = \right)$ 3222·74 cubic feet per minute at standard temperature and pressure. But these gases in the furnace had a temperature of 1750°, or (1750—60=) 1690° higher than the standard, and as gases expand 0·3667 for every 180° Fah., the 3222·74 cubic feet will become in the furnace 14318·31 cubic feet. The area between the top of the bridge wall and the bottoms of the boilers is

6·415 square feet, consequently to pass 14318·31 cubic feet of gases, the velocity per minute must have been $\left(\frac{14318{\cdot}31}{6\,415} = \right)$ 2232 feet, or 37·2 feet per second. This velocity, however, is not maintained; it decreases if the same cross-section of flue be preserved, in the ratio that the gases decrease in bulk from loss of temperature, becoming slower and slower as they approach their exit. The temperature of the gases at the mouth of the flues where they enter the chimney, was 694° Fah., or (694—60=) 634° above the standard temperature; the expansion of the gases due to this temperature would increase the original bulk of 3222·74 cubic feet at standard temperature, to 7385·23 cubic feet, and as the cross area of the flues is 4·712 square feet, the velocity of the gases per minute when they enter the chimney would be $\left(\frac{7385{\cdot}23}{4{\cdot}712} = \right)$ 1567·32 feet, or 26·1 feet per second.

The large boilers are 10 years old, and have been nearly in constant operation day and night during the whole of that period. They have during that time been twice repaired, when particular plates of the iron have been found deeply honey-combed, while others adjoining were nearly as sound as ever; about the honey-combed portions salts of copper were found, carried there from the copper pipes of the condenser. The present cross-boiler is the third that has been put in entirely new during the 10 years; the destruction here is much more rapid, and the salts of copper are found in much greater quantities. It will be remembered that the feed water is pumped directly from the copper condenser through copper feed pipes into the cross-boiler. Pure water is used in the boilers, and any deficiency of the distilled water furnished by the condenser, is supplied by rain water; on an average, 600 pounds of rain water are required per 24 hours steaming. The condenser has been used 9 years in connexion with these boilers.

Efficiency of the Condenser.

The condenser is 9 years old, and has been, with occasional short intervals, in constant use day and night. During these 9 years the upper two "gridirons" have been renewed once; the lower three "gridirons" are the same as originally put in. The upper gridiron first receives the exhaust steam as it leaves the cylinders, consequently the heat is there the greatest as well as the washing off of the salts of copper by the rush of the steam current; this portion therefore goes first, and the wasting of the metal appears on close examination to have taken place about equally on *both* sides the copper; that is to say, on both the sea water and distilled water sides. The weight of copper in the condenser is 885 pounds. When working ordinarily, that is to say, receiving about 97,000 cubic feet of steam of atmospheric pressure per hour, equal to 3566 pounds of water; there are required to be added to the boilers per hour about 25 pounds of water, the loss is consequently $\left(\frac{25\times100}{3566} = \right)$ ·7 of 1 per centum; that is to say, all the steam received by the condenser, less ·7 of 1 per centum, is returned to the boilers in the state of distilled water at the temperature of 130° Fah. in the reservoir, and

122° Fah. when entering the boilers. This loss of ·7 of 1 per centum may be considered as due entirely to leakage.

The space displacement of the pump piston for supplying the condenser with cold water, is 0·156 cubic foot per stroke, and allowing it to discharge two-thirds of its capacity of water, it will, at its average speed of 78 double strokes of piston per minute, discharge 973·44 cubic feet of water, or 60,840 pounds of water per hour, which gives for condensing each pound of steam of atmospheric pressure to water of 130° Fah., $\left(\frac{60840}{3566} = \right)$ 17 pounds of water. The temperature of the condensing water was 36° Fah.; temperature of the water overflowing from the condenser was 80° Fah.; it had gained, therefore, only (80—36=) 44° of temperature, and was still (130°—80°=) 50° Fah. below the temperature of the condensed steam. The weight of condensing water at 36° Fah. required to condense a pound of steam of atmospheric pressure so that the temperature of the mixture shall be 130° Fah., will be, taking the total heat of steam of atmospheric pressure at 1146°·6 Fah., $\left(\frac{1146{\cdot}6-130}{130-36} = \right)$ 10·81 pounds. The weight required with the surface condenser, we have seen to be 17 pounds.

No mechanical provision was made for the distribution of the cold water and steam among the pipes, both currents being allowed to take their own routes from their places of entrance to those of exit. In view of this fact, and of the small amount of surface contained in the condenser proportionably to the quantity of steam to be condensed, viz: only 304 sq. feet to condense $1616\frac{2}{3}$ cubic feet of steam of atmospheric pressure per minute, or 1 sq. foot of surface per 5·32 cubic feet of steam, using only $\left(\frac{(17{\cdot}-10{\cdot}81) \times 100}{10{\cdot}81} = \right)$ 57·3 per centum more than the theoretic quantity of condensing water. I consider the result obtained, which is the condensation of all the steam entering, and its return minus the ·7 of 1 per centum loss by leakage, to the boilers in the shape of distilled water, as very remarkable. The number of years the condenser has been in operation, and the uniform satisfaction it has always given, must not be overlooked in making up an opinion on this description of instrument.

AMERICAN PATENTS.

List of American Patents which issued from April 7th, to April 21st, 1857, (inclusive,) with Exemplifications.

APRIL 7.

1. For an *Improvement in Harvesters;* Samuel S. Allen, Bristol, Pennsylvania.

Claim.—"The combination of the upper platform and sliding pole, with the main frame and inclined draft rod or chain, when the same are constructed and arranged for joint operation."

2. For an *Improved Mode of Clinching Spikes;* Horatio Bates, City of New York.

Claim.—"Securing a spike or nail by boring a hole in the timber of less depth than

the spike or nail itself to receive it, and inserting thereinto, before the spike or nail, a ball or lump of metal of substantially similar character, to deflect the point thereof when it is driven, and thereby cause it to clinch itself."

3. For an *Improvement in Steam Boilers;* Smith Baldwin, St. Louis, Missouri.

Claim.—"The arrangement of the cylinders, the water tubes, flues."

4. For an *Improvement in Window Curtain Fixtures;* Ransom Ballou, Jr., and Benjamin F. Hooper, Albany, New York.

Claim.—"A tightening button or pulley, affixed at or near the circumference of a rotating disk or barrel, the said disk being combined either with the pawl and fixed ratchet, or with other means within it for maintaining the necessary stress upon the cord."

5. For an *Improvement in Processes for Treating Moss for Matresses;* Samuel Baker, City of New York.

Claim.—"The method of treating or preparing the moss of commerce to serve as a substitute for curled animal hair."

6. For an *Improved Apparatus for Exhibiting Stereoscopic Pictures;* Alexander Beckers, City of New York.

Claim.—"1st, Arranging the pictures at right angles to the endless belt. 2d, The mode of securing the pictures in the grooved slides, by means of the elastic bands and notches in the ends of the grooved portions of the slides."

7. For an *Improved Road Scraper;* Chauncey Blakeslee, Ashtabula, Ohio.

Claim.—"The grading blade, arranged and combined with the runners, with the draft forward of the edge of the blade, for the purpose of causing said runners to serve as guides or gauges thereto, and preventing the blade from dropping into furrows or depressions."

8. For an *Improved Shingle Machine;* John L. Brown, Indianapolis, Indiana.

Claim.—"The construction of a self-feeding shingle machine, by the arrangement and combination of the wheel upon the shaft, the wheel, the eccentric, the lever, the bolt, and the oscillating table."

9. For an *Improvement in Hoisting Winches for Ship Board;* Joel Bryant, Brooklyn, New York.

Claim.—"The construction and use of windlasses or winches, having a sheave pulley or wheel set on the axle of said windlasses or winches back of their boss or head, and connecting and operating with other sheaves or pulleys, operated by the said windlasses or winches, or by the tackle connecting therewith, for hoisting the sails of vessels, and for such like purposes."

10. For an *Improvement in Folding Window Blinds;* Sylvanus S. Clark, Manchester, New Hampshire.

Claim.—"1st, The employment of movable upright pieces containing notches to receive and constitute bearings for the tenons of the blind slats, arranged to operate within the stationary sides of the blind or shutter framing, for the purpose of confining the tenons of the slats when the blind or shutter is down, or of liberating the tenons to allow the blind or shutter to be drawn up or folded. 2d, The guide plates for conducting the tenons of the bottom slat clear of the notches during the drawing up of the blind, such plates being attached to portions of the tenons of the said slat that extend beyond the ends of the tenons of the other slats, into cavities that are made within the stationary side pieces of the blind, for the cords or chains by which the blind is raised or folded to work through. 3d, The construction of the chains with stops on the links, arranged in such manner as to allow the links to fold freely inwards or away from the slats, and prevent them folding between the slats. 4th, The application of the spring and cord to the upper slat, in combination with the connexion of the slats by the chains at their inner edges, for the purpose of effecting the closing of the slats when the blind or shutter is down, and keeping them closed unless held open by other means. 5th, The suspension of the top slat from fixed pins in the cap of the frame of the blind or shutter, by slotted plates, which admits of all the movements. 6th, The curved lever and sliding ratchet bar, applied to operate upon the lower slat, and open the blind or shutter from the interior of the window. 7th, The hook attached to the inner edge of one of

the slats, and operating in combination with the spring and cord, to hold open the slats of the upper portion of the blind or shutter, while the lower portion remains closed."

11. For an *Improved Machine for Making Rivets;* Richard H. Cole, St. Louis, Mo.

Claim.—"1st, Forming a successive series of die boxes of a double series of sections, which are combined with the parallel peripheries of two equal sized intermittingly rotating wheels, when the arrangement of the bearings of one or both of said wheels is such as to allow of a sufficient amount of lateral play thereof, to enable a pair of said sections to be firmly pressed against each other at the termination of each intermittently rotary movement of said wheels. 2d, Combining the curved gauge plate and the cutting plate with each other, and also with the cam wheels. 3d, The combination of the cam wheels with the gauge plate, the cutting plate, and the header."

12. For an *Improved Cutting Apparatus for Harvesters;* Samuel Comfort, Jr., Morrisville, Pennsylvania.

Claim.—"As an improvement on the cutting apparatus of harvesters, for which a patent was granted me on the 18th day of March, 1856, the springs with their twisted or bent projections, in combination with the endless chain of cutters and stationary knives."

13. For an *Improvement in Reefing Sails;* Washington F. Davis, Winthrop, Mass.

Claim.—"Arranging the ranges of folding eyes or grummets, and the reefing lines above the reef band, or with respect to the upper yard, in order that the sail, when reefed, shall at the same time be folded or plaited against the upper yards. Also, the arrangement of the lines of grummets or eyes at unequal distances apart, in order that the minor part of each fold of the sail may come underneath the yard, or the yard project beyond it when the sail is reefed."

14. For an *Improvement in the construction of Baskets;* Joel A. H. Ellis, Springfield, Vermont.

Claim.—"The new and improved manufacture of basket as made of vertical splints, two bottom boards, top hoops, and staple connexions, or their equivalents. Also, the arrangement of the staple connexions, viz: so that each one shall lap on the two next adjacent it, the same causing the fibres of the wood of the splint to be drawn together by the strain of the load of the basket."

15. For an *Improvement in Reaping Machines;* George Esterly, Heart Prairie, Wis.

Claim.—"The combination of the common supporting beam, with an adjustable raker's seat or stand and platform, when said parts are constructed and arranged in relation to each other, so as to be easily adjusted to any desired position, and there firmly held while the machine is in operation, and the raker on the platform."

16. For an *Improvement in Forming Spiral Springs for Chairs, Sofas, and other articles;* John T. Foster and Jacob J. Banta, Jersey City, N. J., and James H. Banta, Piermont, New York.

Claim.—"The spirally cut metallic plate spring, applied to sofas, chairs, and similar articles."

17. For an *Improvement in Machines for Felting Hat Bodies;* Wm. Fuzzard, Cambridgeport, Massachusetts.

"My invention relates to an improvement in a felting machine formerly patented by me, and which consisted of an apron attached to a drum, and working between two pressure rollers fitting in a swinging or vibrating frame, the article to be felted being placed on the lower part of the apron."

Claim.—"The employment or use of the roller, one or more attached or applied to the machine."

18. For an *Improvement in Rotary Pumps;* Richard Gilbert, Rochester, N. Y.

"The nature of my invention consist in combining with the annular piston of rotary pumps, a vibrating link, which combination is found to work much easier, and much more perfectly than that of the annular piston and radial arm."

Claim.—"The vibrating link (or arm), in combination with the annular piston."

19. For an *Improved Current and Paddle Wheel;* James H. Hanchett, Beloit, Wis.

Claim.—"1st, Suspending water and paddle wheels, by means of radius bars. 2d,

The method of maintaining the planes of the faces of the floats of wheels that oscillate in a determinate relation to the radius of oscillation of the wheel."

20. For an *Improvement in Machines for Cutting Fringes;* Wm. J. Horstmann, Philadelphia, Pennsylvania.

Claim.—"The combination of the circular cutters and the feeding rollers."

21. For an *Improved Gate Post attachable to any Panel of its corresponding Field Fences;* James G. Hunt, Cincinnati, Ohio.

Claim.—"The application of a portable post to a fence, whether portable or permanent, for the purpose of hanging or fastening thereon a gate."

22. For an *Improvement in Photographic Trays;* Daniel J. Kellogg, Rochester, New York.

Claim.—"The employment of the movable bottom."

23. For an *Improvement in Smut Machines;* Israel Kepler, Milton, Penna.

Claim.—"In the construction of the stave, the horizontal ribs, and openings, when said ribs are cut away on their inner faces, so as to facilitate and concentrate the blast of air that is to pass through them, to carry off the smut and other impurities."

24. For an *Improvement in Lamp Burners;* A. M. Knapp, Medford, Massachusetts.

Claim.—"The arrangement in a movable burner so that it may be applied to a common glass lamp of the perforated screen apertures, small column and cam, provided with an eccentric slot, whereby I am enabled to produce a steady and even flame."

25. For an *Improved Arrangement of Staging Brackets;* Joseph C. Latham, Phœnixville, Connecticut.

Claim.—"The use or employment of the bracket, the strap, and dog."

26. For an *Improved Liquid Metre;* Otto G. Leopold, Cincinnati, Ohio.

Claim.—"1st, Suspending the wheel or drum, and floating it so as to reduce the friction of its bearing to the smallest possible amount, and thus, in addition to the other means rendering it peculiarly adaptable to the registering of the flow of liquids. 2d The arrangement of dividing the inlet opening into an appropriate number of small apertures so as to protect the wheel from the gross impurities of the water, and thus preventing its free motion from being disturbed."

27. For an *Improvement in Harvesters;* Pells Manny, Waddam's Grove, Illinois.

Claim.—"The combination of the smooth elastic metal cap or sheath, connecting the divider with the main wing, with the reversed hook or bent projecting end of an automatic rake, when said parts are constructed and arranged for joint operation."

28. For an *Improvement in Harvesters;* Pells Manny, Waddam's Grove, Illinois.

Claim.—"Raising and lowering the finger bar of harvesters, by means of the adjusting staunchion, when used in combination with the elastic shoe, rigidly attached to the draft bar or pole, and jointed to the main frame in front of the driving wheel, and back of the finger bar."

29. For an *Improved Arrangement of Carriage Springs;* Rinehart P. March, Jeffersonville, Pennsylvania.

Claim.—"The arrangement of the combination spring, axle, slotted bar, and guide pin, for the purpose of supporting the spring and preventing lateral strain, and for making of equal strength a much cheaper and lighter carriage than usual."

30. For an *Improvement in Securing the Legs of Sectional Corn and Cob Mills;* Richard F. Maynard, Baltimore, Maryland.

Claim.—"The mode of securing the legs and the parts of the concave together."

31. For an *Improvement in Corn and Cob Mill;* Richard F. Maynard, Baltimore, Md.

Claim.—"The arrangement of the teeth so as to break points, and to form a series of interrupted screw threads by their inclined points."

32. For an *Improvement in Window Curtain Fixtures;* Purches Miles, Hartford, Connecticut.

Claim.—"The arrangement of the springs for the three-fold purpose of keeping the

band in place, supporting the shade at any required height, and preventing the roller from having end play."

33. For an *Improvement in Sound Boards of Piano-Fortes;* Joseph Newman, Baltimore, Maryland.

Claim.—"In piano-fortes and other musical instruments having two or more sounding boards, making the bridges upon the lower sounding board or boards to protrude through, or rise beyond, the sounding board or boards above them."

34. For an *Improved Trimming Jack;* Garret J. Olendorf and Edwin R. Tripp, Middlefield, and Samuel Harper, Cooperstown, New York.

Claim.—"The construction of shaft, in connexion with frame and lever operating the dies."

35. For an *Improvement in Hawser Holes for Vessels, &c.;* Jason C. Osgood, Troy, New York.

Claim.—"Beveling the edges of the pulleys."

36. For an *Improvement in Machines for Paring Apples;* J. J. Parker, Marietta, O.

Claim.—"The combination of a spring holder with the knife arm."

37. For an *Improvement in Paper Ruling Machines;* Charles L. Pond, Buffalo, New York.

Claim.—"The spring connected box and shaft, combined with the stop wheel and the detachable rim."

38. For an *Improvement in Strings for Musical Instruments;* William Randle, Florida, New York.

"The nature of my invention consists in providing for each string one or more springs, to prevent the strings from breaking when exposed to the dampness of the atmosphere, or other causes which will contract the strings and cause them to break, which is often the case with the ordinary mode of construction."

Claim.—"The application of one or more springs applied to each string, or its equivalent."

39. For an *Improved Field Fence;* Samuel Rains, Lancaster County, Virginia.

Claim.—"The making of a fence without posts when the panels are fastened together."

40. For an *Improved Wrench;* Ezra Ripley, Troy, New York.

Claim.—"Making the levers combined together with wrench jaws so arranged that the levers do not tend to spread open when used as an adjustable wrench."

41. For an *Improved Mode of arranging and operating Window Shutters;* D. Rohan, Cincinnati, Ohio.

Claim.—"Attaching the lower end of the shutter to the slide, or its equivalent, which is fitted in the box below the sill of the window casing, the bars being used in connexion with the slide, and connected at the proper time to the slide by the catches which are actuated by the weights and blocks."

42. For an *Improved Gold Separator;* Edward L. Seymour, City of New York.

Claim.—"The use of the sections or frames when perforated or constructed so as to open or shut the communication between the upright tubes or compartments, for the passage of materials containing gold or other substances of air, or of water, as may be required, the whole operating in connexion with the hopper."

43. For an *Improvement in Veterinary Syringes;* William Somerville, Buffalo, N. Y.

"My invention consists in providing the plunger with a spring and catch, by which the efficiency of the instrument is much increased."

Claim.—"Providing the syringe with the spring and catch, or their equivalents."

44. For an *Improved Machine for Manufacturing Cylindrical Boxes;* Horace S. Smith, Elijah Hinson, and M. S. Richardson, Rutland, Vermont.

Claim.—"The cutters attached to, or formed on, the semi-cylindrical shell, the cutters attached to the ends of the solid semi-cylindrical projection, and the cutter attached

to the inner end of the semi-cylindrical projection. Also, in combination with the cutters, the saw attached to the swinging bar."

45. For an *Improvement in Ships' Steering Apparatus;* Samuel N. Smith, City of New York.

"This invention relates to that description of steering apparatus in which the rudder is turned by means of a curved rack and pinion, the pinion being located upon the wheel shaft."

Claim.—"Locating both of the bearings of the wheel shaft upon the tiller. Also, locating the brake upon the tiller and wheel shafts."

46. For an *Improved Road Scraper;* George W. Thomas, Wickford, Rhode Island.

Claim.—"The adjustable side scrapers, in combination with the front release scrapers, when so arranged as to throw the dirt inwardly towards the centre of the road, and in a crowning form, for the purpose of giving a natural drainage to the road."

47. For an *Improvement in Railroad Car Brakes;* Robert M. Wade, Wadesville, Virginia.

"The character of brake to which my invention applies, is that in which the breaking action is effected by the strength of a spring: the invention consists both in the manner of applying the rubbers to the wheels, and withdrawing the same."

Claim.—"The wedge, lever, and bar, constructed, arranged, and operating in combination with the rack. Also, the aforesaid wedge, lever, and bar, in combination with the slack chain for effecting the simultaneous application of the brake rubbers throughout the train."

48. For an *Improvement in Machinery for Making Rope;* Milton Wallwork, Hoosick Falls, New York.

"This invention relates to that description of rope making machine generally known as the sun and planet machine, and consists in certain means of controlling the speed of the strand flyers for the purpose of enabling the twist of the strands to be varied with facility."

Claim.—"The construction of the stationary circle or ring with which the rollers on the flyers run in contact to produce the rotary motion that gives the twist of a series of segments, one or more of which may be removed or withdrawn from the ring or circle or replaced therein at pleasure, for the purpose of varying the twist."

49. For an *Improvement in Fixtures for Curtain Rollers;* C. H. Wheeler, Boston, Massachusetts.

"The object of my invention is to produce a fixture that can be applied to curtains when hung inside of the bead that confines the sash in place, and that shall operate without the use of springs."

Claim.—"Perforating the block in which the curtain rod revolves, so that it may be slipped back upon the pivot, and securing it to the bracket by the dove-tailed ears."

50. For an *Improvement in Printers' Composing Sticks;* Daniel Winder, Cincinnati, Ohio.

Claim.—"The combination and arrangement of the several parts of the composing stick, as constructed with each other."

51. For an *Improved Invalid Chair;* Ransom Witherell, Huntington, Mass.

Claim.—"Attaching the bars to one end of the bars by a joint, and attaching the bars in a similar manner to the opposite ends of the bars, the bars with their cross piece forming the back of the chair, and the bars with their rounds the foot rest, the bars being pivoted to the opposite sides of the stationary chair seat, and perfectly balanced on their pivots."

52. For an *Improved Method of Working Pumps;* William Wright, Hartford, Conn.

Claim.—"The arrangement for working a double bucket pump, consisting of a cam placed centrally over said pump, combined with the buckets thereof, by bell cranks, so situated that one arm of each of said cranks bears at the same time upon opposite or nearly opposite points of the edge of the cam, whereby the necessary strength and stability may be given to the several parts, while preserving the regular throw of the buckets."

53. For an *Improved Method of Constructing Iron Fences;* William S. Fuller, Millburg, Assignor to Wm. D. Cutler, Worcester, Massachusetts.

Claim.—"The manner of connecting the pieces and rods together, by means of the lugs and collars."

54. For an *Improved Construction of a Retort;* Alfred Monnier, Camden, New Jersey, Assignor to self and Isaac Gattman, Philadelphia, Pennsylvania.

Claim.—"The method of preventing the rapid destruction of retorts by placing the same within a fire-clay casing, and packing the space intervening between the retort and said casing with any substance or mixture of substances incapable of combining when heated either with the clay or metal retort."

55. For an *Improved Car Lock;* Henry Ritchie, Assignor to self, Samuel C. Thompson, and George W. Westerfield, Newark, New Jersey.

Claim.—"The combination of the sliding plate, tumblers, and jaws, arranged and operating in connexion with the bolt for releasing the hasp."

56. For an *Improved Machine for Splitting Hoop-Poles;* Joseph and Sylvester Sawyer, Fitchburg, Mass., Assignors to The American Hoop Machine Co.

Claim.—"Moving the knife back from the rolls in proportion as the latter are separated from each other. Also, connecting the knife with the centre of the shaft of the movable feed roll by means of the arm. Also, the friction rolls in the knife stock."

57. For an *Improvement in Hemp Brakes;* James Barkley, St. Louis, Missouri.

"The nature of my invention consists in a hinged platform, so arranged and constructed with suitable attachments as to graduate the speed and sweep of stroke of the brake at the proper time, by the natural traveling motion of the workman or operator upon said platform, thus making the weight of the operator the medium through which the operation of the brake is regulated, leaving the hands entirely free to handle the stock."

Claim.—"The hinged platform, arranged in combination with the mechanism, and so that the attendant upon the platform may change the speed and stroke by merely changing his position, and thus leave his hands at liberty to manage the hemp."

58. For an *Improvement in Propellers;* Robert Griffiths, London, England; patented in England Sept. 13, 1849.

Claim.—"Making propellers with an enlarged boss on the shaft to which the blades are secured, extending say to about one-third of the entire diameter, and this I claim in contradistinction to the solid hub of a diameter merely sufficient for strength as heretofore employed, whereby I avoid the centrifugal or broken action of the water near the centre, which is known to be prejudicial to the propelling action of the blades, and by which also I avoid the resistance due to the action of the blades near the centre, where they otherwise would be in a plane nearly coincident with the plane of the axis of the shaft. Also, in combination with an enlarged boss, the method of connecting the blades therewith, by means of a shank or stem on the blades fitted to, and capable of being turned in the said boss to adjust the pitch of the blades. Also, the adjustment of the pitch of the propeller, by the connexion of the propeller blades with the enlarged hollow boss or hub, and the self-adjusting apparatus. Also, in combination with the enlarged hollow boss or hub, the blades narrowed towards their outer ends, and the round shank attachment to the hub."

59. For an *Improved Mill for Cleaning Castings;* Henry R. Remsen, Assignor to self and W. J. Noyes, Albany, New York.

Claim.—"The use in a horizontal revolving mill for cleaning castings or hollow ware of open work, lattice or grated partitions, parallel to, or in line with, the axle."

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60. For an *Improved Boring Machine;* Jonas Rosenbury, Cherryville, New Jersey.

Claim.—"The arrangement of devices."

61. For an *Improved Cooler for Wine, Beer, and other Liquids in Barrels;* John F. Bergin, Northumberland, Pennsylvania.

Claim.—"Arranging the two cylinders eccentrically in respect to each other, when the widest portion of the chamber is directly below the opening."

62. For an *Improvement in School Slates;* Samuel R. Burrell, City of New York.

Claim.—"The application of a permanent or fixed pile, and also a movable pile, to the ordinary slate frame of commerce."

63. For an *Improvement in Machinery for Crossing the Fibres of Wool in making Felt Cloth;* Thomas B. Butler, Norwalk, Connecticut.

Claim.—"The arrangement and use of regular polygon heads, cams, guide plates, and traversing rods, connected with and operated by the shaft."

64. For an *Improved Preparation of Sugar called Table Manna;* Merano Butterfield, Indianapolis, Indiana.

Claim.—"The use of the sulphate of alumina and potassa, or its equivalent, in the manufacture from white sugar of a substitute for honey."

65. For an *Improvement in Hot-Air Furnaces;* John H. Cahill, Philadelphia, Penna.

Claim.—"The clean-out holes in the lower radiator, in combination with the short stopper tubes, fitting adjustably within the same, and opening through the lower plate of the radiator."

66. For an *Improvement in Levels or Inclinometers;* Thomas A. Chandler, Rockford, Illinois.

Claim.—"The combination of an entire graduated circle, provided with a pendulum and index, with the two parallel sides of the level stock, whereby I am enabled to apply either side of said stock to the surface whose direction is to be ascertained, and at the same time have the index facing the operator, in whatever position he may be placed. Also, the level composed of the before enumerated parts in combination, whereby, among other things, either edge of the instrument may be used uppermost with its face or dial towards the operator, and when any two of the pointers are screened from sight by an intervening body, the third will indicate the inclination of the surface to which the instrument is applied, and the angles at the head and foot of a rafter will be indicated at the same time."

67. For an *Improvement in Lifting Jack;* John S. Chesnut, Philadelphia, Penna.

Claim.—"In combination with the rack lever and the bracket, the thumb lever, so that the user may, with one and the same hand, work the jack, and throw the bracket in and out of gear with the rack at pleasure."

68. For an *Improvement in Raking Attachments for Harvesters;* Isaac H. Conklin, Rockford, Illinois.

Claim.—"Operating the hopper attached to the shaft, by means of the pin on the plate, in combination with the pinions on the shaft, when the said parts are constructed and arranged in relation to the platform."

69. For an *Improved Machine for Sawing Shingles;* Jonathan Creager, Cincinnati, Ohio.

Claim.—"The combination of the bench, working rest, and adjustable stops, with circular saw fed transversely of the shingle by treadle, and cutting longitudinally."

70. For an *Improvement in Lifting Jack;* Robert W. and Daniel Davis, Yellow Springs, Ohio.

Claim.—"The application of the power centrally beneath the self-clutching gripe or collar, whereby its action is directed in the line of the axis of the ratch bar. Also, the free upright connecting rods upon which the reciprocating gripe rests, arranged and operating in combination with said gripe and the lever."

71. For an *Improved Apparatus for Filtering Liquids;* Benjamin N. De Buffon, Paris, France; patented in France May 3, 1856.

"My invention consists in the employment of a cylindrical tube of iron, or other suitable metal, surrounded by a cylinder of wire gauze, containing charcoal or other filtering material."

Claim.—"1st, The general arrangement and construction of tritular apparatus for filtering water and other liquids. 2d, The mode of constructing stationary and tubular filters, in which the impure water to be clarified is passed from the exterior to the interior of the filter. 3d, The compressing of the filtering material."

72. For an *Improvement in Machinery for Manufacturing India Rubber Hose;* Thomas B. De Forest, Birmingham, Connecticut.

Claim.—"1st, The employment of a pressure roller or rollers, of a length equal to a comparatively small portion of the length of the mandrel, when such roller or rollers or the mandrel have a longitudinal movement. 2d, Giving the mandrel a rotary motion independently of the pressure rollers, and causing the latter to derive motion from the mandrel. 3d, Making the pressure rollers of a tapering form, so as to exert less pressure nearest where the laying or winding of the fillet or fillets takes place; and a gradually increasing pressure as the wound fillet advances further between them. 4th, The mode of operating the mandrel, and the pressure and guide rollers, whereby the fillets are first wound up on the mandrel to form the hose, and the hose is afterwards pushed longitudinally off the mandrel, viz; by giving rotary motion to the mandrel, while the carriage which contains or supports the rollers moves in one direction longitudinally in relation to the mandrel, and suspending the said rotary motion while the rollers move in the opposite direction. 5th, The combination of the clamps, flanched collars, pins or screws, springs, and elliptic collars, applied and operating in the head stock, to clamp the hose to the mandrel, and liberate it therefrom. 6th, The combination of the two spring clutches and the levers, the spring bolts, the tappets and the sliding bar, the whole operating together, to cause the roller carriage to be driven in opposite directions alternately."

73. For an *Improvement in Washing Machines;* Thomas A. Dugdale, Richmond, Ind.

Claim.—"Combining the vibrating frames and rollers, the plate, the knob, and pin, with the washboards and rollers."

74. For an *Improvement in Reefing Ships' Sails;* James Emerson, Worcester, Mass.

"My improvement relates to that class of reefing sails where the extra yard is used; the reefing being effected by chains or ropes leading down to the deck of the vessel, so that the sails can be reefed while the men are on deck."

Claim.—"The adjustable clamps when managed so as to be enlarged or decreased as required. Also, the screws and claws on the roller, for spreading the sail."

75. For an *Improvement in Revolving Fire Arms;* Josiah Ellis, Pittsburgh, Penna.

"My invention consists in the use and combination of a hammer, trigger, and spring pawl, so constructed and arranged, that the breech may be rotated, and the hammer raised to and retained in position at full cock, preparatory to firing, either by pulling the trigger, or by lifting the hammer by the hand, so that the pistol may be cocked by the hammer, or cocked by pulling the trigger, or fired without standing at full cock, at pleasure."

Claim.—"1st, The use of a self-acting spring stop, operating directly by the trigger, in combination with suitable recesses in the revolving chambered breech, or their equivalents, for the purpose of locking the breech at the moment of firing, and leaving it free to rotate at other times. 2d, Making a cam for the bearing of the trigger spring, on the trigger back of the centre on which it springs, in order to admit of easy play and short motion of the spring, where a long sweep of the trigger is necessary. 3d, Constructing and arranging the trigger spring in such a manner as to serve the double purpose of a trigger spring and spring stop for locking the bolt. 4th, The combination and arrangement of the claw and notch on the hammer, the pawl or catch, and cam on the trigger, or other equivalent devices, for the purpose of retaining the hammer in its respective position when at full cock, and for effecting the rotation of the breech and cocking of the hammer preparatory to firing, either by lifting the hammer or pulling the trigger."

76. For an *Improvement in Machines for Forming the Brims of Felt Hats;* William A. Fenn, New Milford, Connecticut.

"My invention consists in the employment or use of a plain and a corrugated roller, vibratory clamp bar, and stretching segment, arranged and operating conjointly, whereby the lower portion of the hat body is drawn or stretched out horizontally, or at right angles with the crown, and properly formed, the hat body being placed or fitted over the block, which is rotated by the rollers as the brim is formed."

Claim.—"The employment or use of the rollers, vibrating bar, working over the bed

and the serrated segment, with plate attached, arranged and operating conjointly. Also, in combination with the rollers, segment, and clamp, formed of the lever and bed, the adjustable frame which receives the block, the frame c being fitted within the frame B."

77. For an *Improved Hoisting Bucket for Coal, &c.;* George Focht, Reading, Pa.

Claim.—"1st, The knife-edged bar, arranged with a link and hook, whereby the handle is clasped with the front edge of the bucket. 2d, Pivoting the handle to the front of the bucket near the bottom, and clasping said handle to the front of the bucket, whereby said bucket is completely inverted, when said clasp is unlocked from said bucket, and whereby the tendency of any weight in the bucket is to keep said handle clasped with said bucket."

78. For an *Improvement in Gas Burners;* E. P. Gleason, Providence, R. I.

Claim.—"The peculiar arrangement of the holes, in combination with the connecting tube, and the perforations.

79. For an *Improvement in Treating Gutta Percha;* Robt. Haering, City of N. York.

Claim.—"In vulcanizing india rubber and similar gums, the use of pipe clay, or its equivalent, in combination with sulphur."

80. For an *Improved Expansive Bit;* Alexander Hall, City of New York.

Claim.—"In combination with a boring tool, an expanding bit or bits, whose turned cutting edge and shank passes through a mortise in the shank of said boring tool, and is secured therein by a pin, so that said expanding bit or bits may have a cutting edge from the centre of the boring tool to its extreme outer edge."

81. For an *Improvement in Apparatus for Feeding Fuel to Furnaces;* James Hemington, Richmond, Indiana.

Claim.—"Attaching the feeders to their shafts by joints, and applying springs thereto."

82. For an *Improvement in Coating Metals with Silver;* Levi L. Hill, Hudson, New York.

Claim.—"The combination of cyanide of silver, grape sugar, essence of sassafras, clay, and Paris white, or any of their equivalents respectively."

83. For an *Improved Method of Attaching Adjustable Buckets to the Shafts of Water Wheels;* J. R. Howell, Alexandria, Virginia.

Claim.—"The method of adjusting and securing the buckets to the arms of the water wheel, that is to say, the arrangement of the ribs, mortises, or their equivalents, and bolts, in combination with the flanched end of the arms of the wheel."

84. For an *Engraved Plate Printing Press;* M. C. Gritzner, Assignor to M. J. Gritzner, Washington, D. C.

Claim.—"Covering the wiping rollers or their equivalents, with oil cloth or oiled silk, or any material impervious to ink, for the purpose of having a wiping surface from which ink can be constantly removed by a scraper or otherwise, so as to keep it clean, in contradistinction to cloth, leather, or similar materials which absorb ink. Also, in combination with a reciprocating bed plate, carrying an engraved plate or its equivalent, to be printed from one, two, or more wiping rollers, revolving each upon its own axis, when the said axis has a reciprocating, rotating, or any other motion in a plane parallel with the plane of the bed plate. Also, passing a wiping band over two or more wiping rollers, when said rollers have the compound motion given to them. Also, producing the proper degree of pressure between the cleaning surface and plate, by means of a compressed gaseous or liquid fluid. Also, the manner of securing the plate to be printed from the bed plate."

85. For an *Improvement in Steam Boilers;* Nelson Johnson, Jasper, New York.

Claim.—"In combination with the employment of a direct internal flue, and a direct passage under the bottom of the boiler, both leading from the fire place to the chimney. Also, the arrangement of the two dampers, for the purpose of controlling the direction of the products of combustion, and using the boiler as a direct draft cylinder, boiler, or direct flue boiler."

86. For an *Improved Composition for Tanning Hides;* David H. Kennedy, New Alexandria, Pennsylvania.

Claim.—"The combination of valonia, the sulphate of soda, sulphate of magnesia, or sulphate of potash, and sulphate of alumina, sal soda, borax, or boracic acid, dissolved in water or tan bark liquor, for the purpose of tanning hides and skins."

87. For an *Improved Rammer for many-chambered Breech Fire Arms;* James Kerr, London, England.

Claim.—"Fitting the rammer for ramming the charges in the chambers of the rotating breech of fire arms, in a longitudinal groove in the side of the body or frame, in combination with the cam lever fitted to a mortise in the rammer for operating it."

88. For an *Improved Raking Attachment for Harvesters;* Daniel W. and Henry A. Lafetra, Eatontown, New Jersey.

Claim.—"Operating or giving a reciprocating motion to the rake, by means of the spirally grooved cylinder, in combination with the spirally grooved collar. Also, rotating the cylinder, by means of the self-adjusting wheel or roller, and vibrating shaft."

89. For an *Improvement to Prevent Incrustations in Steam Boilers;* Robt. M'Cafferty, Lancaster, Pennsylvania.

Claim.—"The application and use of gum catechu, to prevent and remove the incrustation in steam boilers and steam generators."

90. For an *Improvement in Wardrobe or Bureau Bedsteads;* James S. McCurdy, City of New York.

"The nature of my invention consists in so constructing a bedstead, that it can be used for sleeping upon, or as a toilet bureau."

Claim.—"The combination of the leaf and slatted sliding frame, and folding legs."

91. For an *Improvement in Molasses Cups;* Daniel W. Messer, Boston, Mass.

Claim.—"The adaptation of a movable surface or lip, (to vessels intended to contain molasses or fluids of the same viscidity,) said surface so situated in relation or position with the spout or channel way, and forming part of the same, that by moving the said surface, the viscid fluid or molasses which remains on the movable surface or lip, after pouring from the said vessels, is, by the practice of my invention, returned to a position where, by the force of gravity, it returns to the vessel, but in ordinary vessels, drips from the mouth or lip."

92. For an *Improvement in Sewing Machines;* Willford H. Nettleton and Charles Raymond, Bristol, Connecticut.

Claim.—"Forming the face of the press bar, next the material to be sewed, with diverging grooves, to keep the cloth stretched widthways, and prevent puckering under the operation of the needle. Also, the looper, formed with the notch into which the needle enters to ensure the taking of a loop, when said looper is combined with the slide and slot, or their equivalents, for giving the necessary sideways motion."

93. For an *Improved Machine for Drying and Pressing Paper;* John North, Middletown, Connecticut.

Claim.—"1st, The apparatus for cleaning the pressing cylinders. 2d, In combination with the pressing cylinders, the drying apparatus, consisting of heated plates or chutes between which the sheets of printed paper are passed on tapes, without touching or dragging thereon."

94. For an *Improvement in Boot and Shoe Heels;* Stephen Oliver, Jr., Lynn, Mass.

Claim.—"My improved manufacture of heel as made by a mould, and in other respects, that is with a gutta percha body and tenon, a concave upper surface, and a bottoming of leather, or its equivalent."

95. For an *Improvement in Ice Breaking Boats;* Zachariah Oram, Camden, New Jersey.

Claim.—"The arrangement of a series of pointed plungers, operating vertically and in line with each other, whereby I have the advantage of the series for line or continuous splitting of the ice, instead of breaking in mass."

96. For an *Improvement in Self-Releasing Doors for Cotton Presses;* George W. Penniston, North Vernon, Indiana.

Claim.—"The traversing bar, in connexion with the arm of the plunger, for the purpose of retracting the key to release the doors when the plunger arrives at the proper point to make the bale being pressed the size required."

97. For an *Improvement in Flutes;* John Pfaff, Philadelphia, Pennsylvania.

"My invention consists in placing the mouth pieces of flutes at right angles, or thereabouts, to the stems or bodies, in order that greater convenience may be afforded to the players, and the distortion of arms, fingers, and neck, required in playing upon flutes of the ordinary construction, may be avoided."

Claim.—"The placing of the mouth pieces of flutes at right angles or thereabouts, to the stems or bodies of the same."

98. For an *Improvement in Watches;* George P. Reed, Waltham, Massachusetts.

Claim.—"Arranging and fastening the barrel, with respect to the pillar plate, (that is, so that it shall extend through the pillar plate, and be fastened to the dial side of it,) in combination with arranging the main gear wheel, so that it shall operate as a barrel head or cover to the barrel, and have the retaining power applied to it."

99. For an *Improvement in Lime-kilns;* William Robinson, Baltimore, Md.

Claim.—"In connexion with the central fire and partition, the arrangement of the side or auxiliary fires, for the purpose of more equally introducing the heat into the stack, and promoting more uniform burning."

100. For an *Improvement in Railroad Car Brakes;* Richard L. Smith, Philadelphia, Pennsylvania.

"My invention consists in the employ of sliding rods, situated below the axles, and extending the whole length of the car, the sliding rods connected to bars passing between rollers on the axles, and similar rollers on shafts, which have their bearing in hangers attached to the rubbers."

Claim.—"The sliding rods, with the bars having double inclined planes, in combination with the rollers, and the rollers when the latter are hung to the axles."

101. For an *Improved Lock and Clasp for Porte Monnaies;* Daniel C. Smith, Tecumseh, Michigan.

Claim.—"The combination of the several parts of the lock and clasp of a porte monnaie."

102. For an *Improvement in Curtain Fixtures;* C. H. Wheeler, Boston, Mass.

Claim.—"I do not claim broadly fastening the curtain to the rod by securing it to a wire that is introduced into a groove in the roll, having a narrow slit for the passage of the curtain, but this I only claim when the sides of the groove are straight and dovetailed, whereby the curtain is securely held to its roll, without other fastening."

103. For an *Improvement in Shirt Studs;* Dutee Wilcox, Providence, R. I.

Claim.—"My improved stud, as constructed with the arrangement and application of a slide bolt, with respect to the disk and the two arms turning on separate fulcra, and so as to operate therewith. Also, so constructing and arranging the disk of the slider, that its periphery shall extend or lap beyond that of the disk, in manner and so as not only to cover the said disk when closed down upon it, but also to enable a person to grasp the said disk between his thumb and finger, without at the same time grasping the disk. Also, forming the two levers with recesses in their heels, so that they may readily lap over and pass by one another without interfering, while being turned on their respective fulcra, and the heels brought close up to the locking slide, to enable it to lock them."

104. For an *Improved Machine for Splitting Wood;* William L. Williams, City of New York.

Claim.—"1st, The combination of the feeding chains with the stationary conveying floor, for effecting the feeding up of the sticks in a fire wood splitting machine. 2d, The movable side clamps operated by a positive motion, governed by the motion of the knives and proportioned to the displacement of the wood by said knives, for the purpose of supporting the sticks laterally, and also of relieving the pressure upon the same. 3d,

The arrangement of the two separate knives, each extending entirely across the feeding floor, and being set at such angle to each other, and such distance apart, as will effect the cross or second cutting upon a block, which is not at that feed receiving the first cut."

105. For an *Improvement in Machines for Threshing Grain in the Field;* J. C. & F. G. Wilson, Cedar Hill, Texas.

Claim.—"The arrangement with a traveling thresher, of an endless gatherer and conveyor, armed with hooked teeth, in rows conforming to the surface passed over, to lift cut grain from the swath, and deliver it to the threshing mechanism."

106. For an *Improved Mode of Attaching Hubs to Axles;* Lorenzo Winslow, Rochester, New York.

Claim.—"The method of attaching the boxes of carriages to the axles thereof, by means of a ring and pin, operated in combination with the ring and pin or pins."

107. For an *Improvement in Apparatus for Boring Artesian Wells;* Jesse N. Bolles, Assignor to M. W. Bolles, Philadelphia, Pennsylvania.

Claim.—"The combination of cylindrical boring rods with cutters and valves, so constructed as to discharge the detritus upon the surface of the ground at every stroke of the drill, or any other mode substantially the same, which will produce the same effect."

108. For an *Improvement in Winding Machinery for Mines;* Edmund M. Ivens, Assignor to self and Lucien H. Allen, Tamaqua, Pennsylvania.

Claim.—"The arrangement of the traveling drums on concentric axes. Also, rotating the traveling drums by means of the rollers, and ribs, or guides, arranged at or near their inner periphery, or in any equivalent manner, whereby their hubs and axes are used merely as guides."

109. For an *Improvement in Baths for Photographic Purposes;* John H. Morrow, Assignor to self and Edwin Bennett, Baltimore, Maryland.

Claim.—"The improved form of constructing a compound or double chambered immersing bath, having an immersing chamber, and a dripping receptacle formed with slopes or inclined upper surfaces. Also, the suspension forked dipper device or tablet holder formed with the spur or ridge. Also, the brackets or rests, in combination with the immersing bath."

110. For an *Improvement in Boot Trees;* William W. Willmott, Assignor to self and Henry F. Gardner, Boston, Massachusetts.

Claim.—"Applying the rollers to curved transverse springs, so that such springs may cause the parts to give transversely, so as to correspond with the dimensions of the boot leg."

APRIL 21.

111. For an *Improvement in Closing Gas Retorts;* N. Aubin, Albany, New York.

Claim.—"The cover with the compound rim fitting it into the groove."

112. For an *Improvement in Steam Traps for Relieving Steam Pipes of Water;* John Avery, Jr., Lowell, Massachusetts.

"My invention relates to a contrivance to be attached to any steam pipe or way, so that it will allow the water of condensation to discharge itself, but at the same time prevent an escape of the steam."

Claim.—"In combination with the outer case, the enclosed mercury holder, and diaphragm, and openings."

113. For an *Improved Door Spring;* Gilbert L. Bailey, Portland, Maine.

"The nature of my invention consists in providing a volute cuniform spring, which is pressed upon by a lever when the door is opened, and its tendency to resume its original shape closes the door, by forcing the outer end of the lever—which has a roller attached—to the outer end of a guide fastened to the casing, and so formed as to cause the greatest pressure on the door when it is nearly shut."

Claim.—"The use of the volute cuniform spring, in combination with post, lever, and guide."

114. For an *Improvement in Ox Yokes;* Isaac K. Bennett, Narrows, Pennsylvania.

Claim.—"The pinions on the pivots of the bow blocks, in combination with the racks into which they gear."

115. For an *Improved Knife for Cutting Veneers;* Gilbert Bishop, City of N. York.

Claim.—"Constructing the knife in sections, each having alternate smooth and toothed cutting edges attached together."

116. For an *Improved Method of Excluding Air from Liquors on Tap;* Absalom F. Boyd, Muskingum Co., Ohio.

Claim.—"The application of the bag to a cask or barrel, for the purpose of preserving the flavor of liquors, by excluding the atmosphere from them when the cask is on 'tap.'"

117. For an *Improved Waste-way in Faucets;* James E. Boyle, Richmond, Va.

"My improvement relates to stop-cocks intended to establish a cut-off at pleasure, the communication between two branches of pipe, and with the reservoir they are connected with, in such a manner that the waste liquid shall not remain in the pipe, where it may cause injury by freezing or other causes."

Claim.—"The recess and orifice, in combination with the channels, when constructed and arranged in relation to the ordinary component parts of stop-cocks."

118. For an *Improved Method of Clamping and Unclamping Panels of Portable Field Fences;* Wm. B. Burnett, Lyons, New York.

Claim.—"The turn button clamp, or its equivalent, for connecting the trays of a portable fence."

119. For an *Improvement in Cask Heaters;* Simeon Burgess, Wayne, Penna.

Claim.—"Combining with the fire-pot, the encompassing hearth, with the adjustable pins for securing casks of different sizes in a concentric position."

120. For an *Improvement in Chimney Dampers;* Augustine Campbell, Philadelphia, Pennsylvania.

Claim.—"The angular frame, provided with a series of valves or vanes."

121. For an *Improved Awl Haft;* Nathan S. Clement, Worcester, Massachusetts.

Claim.—"An awl haft having the chamber for spare awls on the same end with the griping jaws."

122. For an *Improvement in Gas Regulators;* Robert Cornelius, Philadelphia, Pa.

"The nature of my improvement consists in the employment of a metallic spring box, in combination with a valve of peculiar construction, for the purpose of so regulating the flow of gas through the burners, that the escape of gas from any given pipe to a number of burners shall be under a uniform, or very nearly uniform pressure, no matter how many burners attached to such pipe are opened."

Claim.—"1st, The employment of a spring box or boxes, composed of two plates of corrugated metal, and placed intermediately, so as to communicate on the one hand with the gas in the main chamber, and on the other with the branch chamber, being separated by the throttled openings. 2d, The employment of the valve, in combination with the spring box, for regulating the flow of gas."

123. For an *Improvement in Hand Seed Planters;* Thomas Crane, Fort Atkinson, Wisconsin.

Claim.—"The combination of the pivoted and spring actuated block, with the grooved and perforated sliding slat. Also, the combination of the spring with the grooved and perforated sliding slat, in such a manner that the inclined aperture in the back of the planter will operate said spring."

124. For an *Improvement in Hand Seed Planters;* John Decker, Sparta, New Jersey.

Claim.—"The sides fitted in the box, placed relatively with the hoppers, and the plates or clearer attached to the block, when the above parts are combined and arranged so as to operate conjointly."

125. For an *Improvement in Bustles;* Alexander Douglas, City of New York; antedated January 26, 1857.

Claim.—"The combination of the elastic strips, the steadying cloth, (or its equivalent,) provided with strips or fastenings, and the adjusting cord."

126. For an *Improvement in Machines for Blocking Hat Bodies;* Wm. A. Fenn, New Milford, Connecticut.

Claim.—"The cylinder, placed loosely on the spindle or arbor resting on the spring, in combination with the rods or jaws, whereby the hat body may be stretched and adjusted snugly around the hat block."

127. For an *Improvement in Machines for Making Rope;* Harvey W. Fowler, Hoosick Falls, New York.

Claim.—"1st, The stationary disk, arranged in relation to the layer shaft, and the spider, for the purpose of communicating motion to the flyers through the flyer pulleys. 2d, Arranging the series of flyer shafts radially to the layer shaft, and revolving them when the layer shaft is revolved, so as to give the proper degree of twist to the threads or strands, as they leave the spools or bobbins in the flyers, by the peripheries of the flyer pulleys being kept in contact with the face of the stationary disk, the said pulleys being adjustable nearer to, or further from, the centre of the layer shaft, to decrease or increase the speed of the flyers, and through that, to give a less or greater degree of twist to the thread or strand."

128. For an *Improvement in Messenger Shackle Blocks;* George Gilmour, Chelsea, Massachusetts.

"The object of my invention is to enable a purchase block to be connected with a chain cable, when such may be attached to an anchor or vessel, or other article, and particularly when said chain cable may be under water."

Claim.—"The messenger shackle block, or combination and arrangement of the sheaves or pulleys, the forked pawl, the roller, and the chain space or passage. Also, hanging or jointing the parts and the pawl to the remainder of the frame, in order that the roller and pawl may be turned towards the sheaves of the pulley. Also, combining the pawl and the pulley frame, a mechanism by which, by pressure of the chain against the pawl, such pawl may be caused to lift the parts, and the roller to facilitate the movement of the shackle block on the chain."

129. For an *Improvement in Burners of Burning Fluid Lamps;* Charles A. Greene, Philadelphia, Pennsylvania.

Claim.—"The hollow burner with its rounded or semi-spherical cap, and its projection, when the whole is rendered adjustable to the main table tube."

130. For an *Improvement in Tea Kettles, &c.;* James Greenhalgh, Senr., Waterford, Massachusetts.

"My invention consists in connecting the cover of the kettle with the handle or bail, whereby the cover, when adjusted over the top of the kettle, will keep the handle or bail elevated, and when the handle or bail is moved to one side, the cover will be raised."

Claim.—"Connecting the cover with the bail or handle, by means of the bar passing through a slot in the bail or handle."

131. For an *Improvement in Automatic Rakes for Harvesting Machines;* Jonathan F. Green and Israel Dodenhoff, Bloomington, Illinois.

Claim.—"The mode of attaching rakes to endless belts or chains, and of properly guiding the same, whereby the lateral and vertical deflexion of the band is prevented in operating the rakes; that is to say, hinging the rakes to the belt by means of jaws and projecting lips, when combined with guide pins working in grooves to prevent lateral deflexion, while a guide bar keeps the rake down to the platform in raking off the grain.',

132. For an *Improvement in Hand Seed Planters;* Plymon B. Green, Chicago, Ill.

Claim.—"The combination of slide, catch, and stop, constructed and arranged to hold the plunger stationary until the point enters the earth to a certain depth."

133. For an *Improvement in Portable Apparatus for Generating Illuminating Gas;* James O. Halsey, Essex Co., New Jersey.

Claim.—"The air chamber, to allow both the retort to be charged while the fire is in operation, and to carry off the gas that escapes from the said retort, and prevent its entering the room."

134. For an *Improved Cotton Cultivator;* John M. Hall, Warrenton, Georgia.

"The nature of my invention consists in making my hoes in such a manner, and so

attaching them to the wheel, that they shall enter the ground at regular spaces, having a regular space between each cut, and at any required depth."

Claim.—"In combination with the wheel, the adjustable hoes."

135. For an *Improvement in Hemp Brakes;* Wade W. Hampton, Winchester, Va.

"The nature of this invention relates to that class of hemp brakes in which the material is fed, broken, and discharged in hanks."

Claim.—"The clamping, and feeding the clamped material through, between the breakers."

136. For an *Improved Hydrant;* Abraham Hoagland, Jersey City, New Jersey.

"The nature of my invention consists in emptying the pipe of the water (by drawing it out), to a depth below frost, and keeping it closed to prevent the circulation of air."

Claim.—"1st, The emptying the pipe by a self-actiug valved piston with hollow rod. 2d, The construction and use of the valve made of an ordinary bevel winged valve, with the flexible valve added at the bottom, and the cushion added at the top. 3d, The combination of the catch upon the large friction pulley, with the collar, to enable the operator to force down by the crank the piston upon the valve, and open it against pressure."

137. For an *Improvement in Carding Machines;* Hiram Houghton, Somers, Conn.

"The nature of my improvement consists in the arrangement of a third roll, with the seed rolls and licker-in, for the purpose of preventing the fillet of the feed rolls from filling up."

Claim.—"The combination of the third roll with the feed rolls and licker-in."

138. For an *Improved Means for Inhaling Medicinal Agents;* Alonzo G. Hull, City of New York.

Claim.—"The means of inhaling gases, vapors, and medicines."

139. For an *Improvement in Vault Covers;* George R. Jackson, Rye, New York.

Claim.—"Combining glasses of an inverted pyramidal or polygonal form, with the sash or metallic portion of an illuminating vault cover, for the purpose of producing a wider and more perfect diffusion of the light which may pass through said cover into the apartment beneath."

140. For an *Improved Method of Ventilating Vaults;* George R. Jackson, Rye, N. Y.

Claim.—"Connecting the elevated recesses in the ceilings of subterranean apartments, with ventilating lamp posts, or with the flues of a building."

141. For an *Improved Lime-kiln;* Aaron Jeffries, Alleghany County, Penna.

"The nature of my invention consists in the peculiar arrangement of three arched furnaces and three cooling flues, within a hexagonal stack of a lime-kiln."

Claim.—"The combination and arrangement of the three furnaces, with the cooling or draft flues, when the same are constructed and arranged in relation to each other, within a hexagonal stack."

142. For an *Improved Saw-Set;* Oliver P. Judd, Little Falls, New York.

Claim.—"The gauge having the jaws when used in connexion with the revolving plate."

143. For an *Improvement in Reefing Sails;* Francis C. La Croix and Chauncy Barnes, City of New York.

"Our invention consists in a peculiar method of reducing the top-sails from the deck, whereby, if reduced to a storm-sail, the operation of reefing may be dispensed with, or if less reduced, the reefing is rendered much less laborious than by the ordinary methods."

Claim.—"Reducing sails by means of 'tackles,' both ends of the 'falls' of which are secured to the yard."

144. For an *Improvement in Bathing Apparatus;* Louis H. Lefebvre, New Orleans, Louisiana.

Claim.—"1st, Providing a portable frame and casing, used to be placed over persons to administer baths without removing them from their positions, and attaching to said portable frame a graduating stop-cock, provided with a reservoir to receive the con-

densed vapors, with the handle of said cock extending into the frame, and beneath the casing, to enable the person taking the bath to operate the graduating cock. 2d, Perforating the pipe or reservoir from which the vapors issue into the bath on its upper side, and placing beneath it a pipe or reservoir to receive the condensation, uniting said pipes or reservoirs by funnel-shaped connexions, through which the condensed vapors may escape. 3d, The distributing pipe provided with double funnels and stop-cocks, for the introduction of medicated, or other substances, into the bath through the connecting pipe."

145. For an *Improvement in Instruments for Curling Hair;* Mark M. Lewis, Albany, New York.

Claim.—"The construction of a hair curling instrument, by the combination of a taper-formed tube, with a comb which can, by a spring or equivalent apparatus, be made to project from the surface of the tube, or withdrawn into the interior."

146. For an *Improved Shingle Machine;* G. H. Mallary, City of New York.

"My improvements are for the purpose of simplifying the working parts of the apparatus, and causing more accuracy and durability therein; and in so arranging and combining a saw and cutter, as to properly operate upon the shingle at the same time, the cutter or plane being made to vibrate so as to plane the shingle while sawing to the usual taper."

Claim.—"The arrangement of the several devices, by which the bolt is sawed into shingles and planed."

147. For an *Improvement in Smoothing Irons;* Galen B. McClain, Bath, Maine.

"My invention consists in the peculiar construction of the iron, whereby it may be quickly heated, and the heat retained for a considerable length of time."

Claim.—"The sad iron, with its doors or flaps."

148. For an *Improvement in Cooking Stoves;* Thomas King, West Farms, N. Y.

Claim.—"The arrangement and combination of the box, register, or pot hole, and flues."

149. For an *Improvement in Combined Square, Mitre Square, and Bevel;* Alexander McKenzie, Boston, Massachusetts.

Claim.—"The arrangement of the try square, the mitre, and the bevel blade, the latter being hung so as to project upon the opposite side of the stock from the blade, and so as to form when set at an angle of 45° a continuation of the mitre head."

150. For an *Improvement in Dental Forceps;* J. A. McClelland, Louisville, Ky.

Claim.—"Connecting the handles to the head pieces of the instrument, by means of suitable joints and appendages, arranged in such a manner that the shape of the instrument can be so changed as to adapt it to the drawing of upper or lower teeth. Also, combining the beaks with a dental forcep, in such a manner that their length can be increased to any desirable extent."

151. For an *Improvement in Method of Securing the Doors of Hay Presses, &c.;* Cornelius Martratt, New Baltimore, New York.

Claim.—"The form of the crank or loop, the elliptic or eccentric form of the ends of the battens, and the combination of the one with the other, for the purpose of securing a door or hatch, and for the purpose of preventing a sudden and dangerous start of the door in opening, by means of the gradual movement of the battens outward, as the loop is turned off from them."

152. For an *Improvement in Moulds for Casting;* Mortimer Nelson, City of N. Y.

Claim.—"The method of forming moulds for casting britannia and other metals, by backing up a thin metallic face with plaster."

153. For an *Improvement in Grinding Saws;* Albert L. Nippes, Lower Merion, Pa.

"My invention consists in the employment or use of a bearing roller, fitted within a swinging and pivoted or adjustable frame, whereby the roller may be raised and placed out of the way of the saw to allow the same to be turned in its frame or sash, and the roller also allowed to be placed angularly, so that the saws may be ground transversely in taper form."

Claim.—"1st, Placing the roller within a frame which is pivoted to a bar which has

its journals substantially fitted in oblong slots or bearings, so that said roller may be elevated or raised up, free from the saw, and also be adjusted more or less angularly, with the face of the grindstone. 2d, Operating or moving the stone and roller towards and from the saw, by connecting the bearings of the shaft of the stone and the journals of the bar to the disk and ratchet, by means of the arms and the rods."

154. For an *Improvement in Machines for Forming Clay Pipes;* Charles P. S. Wardwell, Lake Village, New Hampshire.

Claim.—"The arrangement and combination of the respective devices, by which the necessary and successive stoppings and startings of the piston are effected, by which the dies are opened and again closed at the proper moments, and by which the knives are brought into action when required, all by simply moving the lever up and back again in connexion with the pressure of the clay against the piston."

155. For an *Improved Method of Adjusting and Holding the Knives of Spoke Shaves;* Manly Packard, North Bridgewater, Massachusetts.

Claim.—"The new arrangement of the clamp screw and bow spring, with respect to the handle and starts of the knife or cutter, and so as to operate therewith."

156. For an *Improved Sawing Machine;* H. F. Purmont, Saginaw City, Michigan.

Claim.—"The sliding heads placed on the blocks, and operated by the pinions, racks, pawl, and ratchet, and the carriage operated by the wheels placed on the shaft."

157. For an *Improvement in Washing Machines;* Joseph F. Pond, Cleveland, Ohio, and Charles L. Pond, Buffalo, New York.

Claim.—"The combination of the vibrating stop piece and its rod, with the screwing plate and the spring bearings of the rollers, when said parts are used in connexion with fluted rollers."

158. For an *Improved Mode of Dumping Railroad Cars;* Wm. Pearce and John Lowrie, Piedmont, Virginia.

Claim.—"1st, The method of discharging cargo from cars by means of a rocking track. 2d, The mine car, constructed without any openings in its sides, ends, or bottom, for discharging its cargo, and with its ends raised higher than its sides. 3d, The ribs or flanches, in combination with the rocking track. 4th, The shoes, in combination with the projections for steadying the rocking track whilst the cars are run on and off. 5th, The method of breaking the rocking car (as it is capsized to discharge the coal, and afterwards raised), by means of the brake and wheel, the latter being mounted on the shaft of a pinion operated by means of a rack and pitman, or their equivalents. 6th, The arrangement of the cam stud, in combination with the latch bar, by which the doors of the rocking car are released when it is brought into proper position to discharge its cargo into the chute."

159. For an *Improvement in Machines for Felting Hat Bodies;* Henry L. Randall, Roxbury, Connecticut.

Claim.—"1st, The rising and falling, and forward and back motions of the felting board, by a system of levers, or their equivalents. 2d, Rotating the bat or roll of material being felted round its own axis. 3d, In combination with the felting board, when operated, the adjustable stationary stocks or carriages for holding the roll or bat."

160. For an *Improvement in Grinding Mills;* Ezra Ripley, Troy, New York.

"My improvement relates to those mills in which the grinding is performed wholly or in part, by or between plates or flat grinding surfaces, one of the grinding plates being constantly revolved."

Claim.—"Giving the grinding plate, when it is applied to a constantly revolving grinding plate, the positive two-fold eccentric and swinging movement, in contradistinction from giving to the grinding plate, when used with a rotary grinder, a simple eccentric, swinging or reciprocating motion, or any other simple or compound movement heretofore positively communicated thereto in grinding mills."

161. For an *Improvement in Harness Saddles;* Palmer Shaw, Syracuse, New York.

"The nature of my invention consists in a method of constructing harness saddles by making the cantle of a single piece of leather, shaped so as to give the desired form to the cantle, and connected by stitching at its upper edge to a raised portion of a piece

of leather from which the skirts are formed, and completing the tree by attaching the parts thus made to a bearing plate shaped in the form suited to the horse's back."

Claim.—"Making the tree of harness saddles to consist essentially of the leather cantle piece, connected to the raised portion of the piece of leather from which the skirts are formed, and the whole attached to the bearing plate."

162. For an *Improved Lubricator;* Hiram Strait, Covington, Kentucky.

Claim.—"The oil cup with its sliding bottom, thumb-screw, guides, in combination with porous oil bags or pieces of sponge, or any other porous and elastic material saturated with oil, and the spring."

163. For an *Improved Current Water-Wheel;* Thomas Stamp, Wetumpka, Ala.

Claim.—"So constructing a current water-wheel, that it may be raised and lowered in combination with the method described for regulating the force of current acting thereon, all arranged and combined."

164. For an *Improvement in Machinery for Winding Conical Bobbins;* Clark Tompkins, Troy, New York, and John Johnson, Roxbury, Massachusetts.

Claim.—"1st, The manner herein described, in which the speed of the winding bobbins is charged, so as to constantly draw the yarn from the fixed bobbins with uniform or nearly uniform swiftness, and thus secure more even tension on the winding yarn, and thereby make the new bobbins of more uniform density than if they were revolved with uniform velocity. Also, in machines for simultaneously winding a series of such bobbins, giving each bobbin spindle of the series the proper independent retreating movement from the yarn carriers as the winding progresses, by means of the mechanism, or its equivalent, in contradistinction from giving each bobbin the separate retreating movement, by means of a fixed guide, acting against the conical part of the wound yarn, and instead of making all the bobbins more endwise. Also, when the revolving bobbins in such machines are separately moved endwise by the mechanism shown in the drawings, connecting each thread of yarn as it runs to a bobbin of the series, with the parts which give that bobbin its retreating movement, by means of a device arranged and operated upon by the tension of the winding yarn, so that whenever a thread of yarn in such case breaks or runs out, the bobbin upon which it was winding at once stops moving endwise, and consequently so that when the yarn is mended, and the winding resumed, the yarn is then laid by the carriers in exactly the proper place on the bobbin, without any re-adjustment of the bobbin by the operative. And, finally, the combination of parts, whereby the rotary motion of each bobbin is stopped whenever it is slid by the mechanism to that place, in respect to the yarn carriers, where the winding should end."

165. For an *Improvement in Harrows;* George W. Tolhurst, Cleveland, Ohio.

"The nature of my invention relates to a harrow which can be rotated to the right or left by simply dragging it across the ground, as the operator may desire, or the slope of the ground require."

Claim.—"The adjustable shield pieces, in combination with the rotary harrow."

166. For an *Improvement in Swage or Cable Springs;* Wm. Wilcox, East Hartford, Connecticut.

Claim.—"The arrangement of the springs, and the springs within the cylinder."

167. For an *Improvement in Harvesters;* J. C. and T. G. Wilson, Cedar Hill, Texas.

Claim.—"Operating the reel by means of the rigid pin and spring arm attached to pulley, in combination with ratchet, arms, and holding spring, when said parts are arranged to operate in relation to each other."

168. For an *Improvement in Oil Cans;* Hiram Wells, Florence, Massachusetts.

Claim.—"The conical cup and ball, so arranged as to close the valve when the can is turned down to deliver the oil contained in it."

169. For an *Improvement in Mode of Attaching Bolting Cloths to Reels;* John Woodville, Chillicothe, Ohio.

Claim.—"Forming the cloth in sections, and securing the sections to the reel by means of the rods and bars which are attached to the bars—bolts and bars which are attached to the rim by screws. Further, the bolts, provided with the oblong and T shaped heads, and washers."

170. For an *Improvement in Blacksmiths' Butteris;* Robert Killmer and Joshua W. Williams, Assignor to Robert Killmer, Newtown, Pennsylvania.

Claim.—"The construction of the butterises with removable two edged bits or blades secured to a plate having rectangular sides, by half flanches only."

171. For an *Improvement in Potato Diggers;* John Taggart, Roxbury, Assignor to self and Wm. W. Messer, Boston, Mass.

Claim.—"The combination and arrangement of the plough, the grid or grate, the revolving tooth lifter wheel or wheels, and the means of discharging the potatoes from the same."

172. For an *Improved Stave Machine;* Henry L. McNish, Assignor to self and David C. Butler, Lowell, Massachusetts.

Claim.—"The angular guides upon the lever, in combination with the connexions and concomitant parts for adjusting the side cutters, to dress staves of different widths, and, at the same time, preserving the proportion between the bilge and the width of the stave. Also, the guide on the bed plate, for the purpose of guiding the staves in a direct line through the machine."

173. For an *Improvement in Brick Machines;* G. I. Washburn and E. H. Bellows, Assignors to selves and C. Washburn, Worcester, Mass.

"Our invention consists in certain improvements on a brick machine, for which letters patent were granted to us on the 7th day of October, 1856, and has for its object to apply the pressure to the brick in the mould, both on top and bottom, and also consists in an improved mode of applying the pressure to a plunger."

Claim.—"1st, The method of applying pressure to the plunger, by means of the radial arms and levers. 2d, The combination of the radial arms with the sliding moulds and moving block, or plunger."

174. For an *Improvement in Argand Gas Burners;* Charles H. Johnson, Assignor to self and Joseph G. Hamblin, Boston, Mass.

Claim.—"The improvement of constructing the supporting tube of the brackets, so that it may not only sustain such brackets, or have them extended from it, but at the same time admit the register to be operated, by simply laying hold of and turning either the globe or chimney, when the friction thereof on the brackets may be sufficient for the purpose."

175. For an *Improved Fluid Metre;* Samuel J. Burr, Assignor to self and Henry F. Read, Brooklyn, New York.

Claim.—"1st, The combination of the flexible partition with shifter, for the purpose of opening and closing the valves or apertures to admit and discharge the fluid, so that the apartments shall be alternately filled and emptied. 2d, The combination of the valves, tube, and flexible partition, so as to make the entering fluid discharge the fluid (alternately) in each apartment, by its pressure upon the opposite side of the flexible partition. 3d, The shifter, as set forth, or in any other form producing the same result, and placed between the two portions of the flexible partition and the packing of the tube, by the outer edges of the two portions of the flexible partition, protecting shaft, and shifter, from contact with the packing, and allowing the said shaft to work freely at the same time. 4th, The combination of the shaft enclosed in the tube with the valve throw."

MECHANICS, PHYSICS, AND CHEMISTRY.

*On an Improved Water Metre.**

In January, 1854, the writer communicated to this Institution a paper on an improved water metre, in which he described several mechanical arrangements whereby water flowing through pipes might be measured with sufficient accuracy for practical purposes, without destroying the pressure or head of water column. In the course of considerable

* From Newton's Lond. Journal, January, 1857.

experience with the these metres, several important improvements suggested themselves, and opportunities occurred of observing the public importance of supplying water by metres.

The chief difficulty that presented itself in endeavoring to produce a practically perfect high-pressure metre, was not so much to obtain a correct measurement under varying circumstances of pressure, as to render the instrument sufficiently durable to resist for years the action of the water and of the impurities carried along with it. It was found necessary to protect all the working parts against the chemical action of the water, to prevent deposit of calcareous matter upon the measuring apparatus, and to combine strength with lightness as far as possible in the construction of the movable parts, in order that they might resist the force of a high water column, and might yet be moved by the slender stream produced by a leaky tap, which in the case of the smaller metres may not exceed half-a-pint of water passing through per minute. Cheapness and compactness of construction were other important considerations not to be lost sight of.

The water, before entering the metre, has to pass through a grating which arrests any solid matter, and is made easily accessible for the purpose of removing, from time to time, the impurities that have collected, when it is found that the passage of the water is obstructed.

It is important to make the area of the inlet nearly equal to the collective area of the outlets of the drum, but a little smaller than the latter. The area of the inlet should accordingly be, for smaller metres, ten per cent., and for the larger, five per cent. less than that of the outlets, to allow for loss of velocity by friction in the drum. This loss may be taken to represent, with tolerable accuracy, the degree of obstruction opposed by the metre to the moving water column. The rapid current of the water through the inlet and the curvilinear channels of the drum has been found to prevent deposit of calcareous matter in these places, which is an important point; for were it otherwise, the metre would gain in relative speed in proportion as the area of the channels was diminished.

Metres constructed on this plan have been found to work continuously for nearly three years under the most varied circumstances, without requiring any alteration whatever. The arrangement made between the manufacturers and the water companies or purchasers of the metres is, that every metre that fails to give satisfaction, in consequence of stoppage or inaccuracy of measurement, shall be exchanged; and experience shows, that the number of metres so returned does not exceed 2½ per cent. in the year; and these for the most part have been sent back only from trivial causes. The more serious accidents have been, that the metre has become choked with gravel or other impurities that had entered through a broken grating; or that the regulating vanes have been broken, and the relative velocity of the revolving drum has been much increased; or that some derangement in the wheel-work of the counting apparatus has taken place. In winter it has happened that the casing of the metre has been burst by frost; but this class of accidents does not concern the mechanical arrangements of the metre. The manufacturers enter into contracts to maintain the metres supplied by them

in good working condition for a term of years, in consideration of the moderate annual charge of five per cent. per annum on the first cost; proving thereby their own confidence in the durability of the metres.

A further object of this paper is to prove, from actual experience, the utility of the metre to water companies and water consumers, and to engineers and others, for general purposes.

Although the metre has been as yet but partially applied by water companies, as the arbiter between themselves and their irregular or trade customers, the advantages to the companies from the prevention of waste, error, and fraud, have been made manifest. The following table gives the results of the application of fifteen metres, showing the difference between the rate paid previous to their application, and the established value of the water actually supplied according to the metres:—

Number of Reference.	Rate Paid.	Value of Water Consumed.	Number of Reference.	Rate Paid.	Value of Water Consumed.
1	£40	£1050	9	£7	£21
2	40	400	10	7	21
3	50	450	11	7	21
4	40	78	12	20	95
5	35	64	13	12	110
6	18	500	14	13	115
7	365	500	15	16	700
8	15	45			

TOTAL ... ... Rate Paid, £685. Value of Water Consumed, £4170.

It appears from this table that the collective rates paid by fifteen consumers amounted to £685; whereas, according to the established value of the water, they ought to have paid £4170, or more than six times the amount. These are no doubt exceptional cases, which have come particularly under the notice of the manufacturers, because the correctness of the metres was disputed by the consumers; but they show the utter impossibility of estimating the quantity of water supplied by a given pipe without the application of a metre. In several of the cases stated in the table, the consumers themselves applied for the metre, because they thought the rate they paid was excessive. They calculated, no doubt, correctly, the water actually required for their manufacturing operations; but did not take into account the lavish waste that is continually going on by taps leaking or left open, by broken pipes, and by inundating instead of washing floors and utensils, &c. From all the information the writer has been able to collect, he ventures to affirm, that fully one-half of all the water supplied by the permanent supply system, which is at present made compulsory by Act of Parliament, is absolutely wasted, without utility either to the consumers or to the water companies. It cannot even be said that the water thus wasted is useful in a sanatory point of view, by cleansing the sewers, because the deposit contained in the sewers can be removed only by flushing them from time to time.

The value of the water that is so wasted may be estimated from the fact that one water company alone, the East London, sells at present nearly 800 millions of gallons a year by metre, which, at the price of 6d,

per 1000 gallons, amounts to a rental of £20,000 per annum. They employ for this purpose only about 200 metres, which are, however, of more than the average dimensions.

In order to detect and prevent all waste of water, it would be necessary to apply a metre not only to the branch pipe of every irregular consumer, but also to every branch main supplying a district or a street. The legitimate consumption of each district or street, would then be soon ascertained, and if in any one week it exceeded that amount, the metre would at once draw attention to the fact; the cause of which would frequently be found to be a leakage from the branch main underground into the sewers, which it is at present impossible to detect.

In order to render the system of supply by metre perfect, it should be extended also to private houses. Objection has been raised against this proposition, on the ground that the poorer housekeepers would economize water with detriment to their own sanatory condition, and also that the cost of the metre is too high in proportion to the amount of rent they pay. These objections are applicable, however, only to the case of laborers' cottages, which indeed might be supplied without restriction, or might be charged a fixed rate, till their consumption exceeded a certain maximum. It should, however, be borne in mind, that the principal value of metres to water companies consists in prevention of waste; and it is a question open for discussion, whether the waste going on in houses on the permanent supply system, does not far exceed the cost of maintenance and investment of a metre, which, indeed, would not be more than the cost of the present cistern and ball taps.

A system of supply by metres, would relieve the officers of the water companies from much watchful care and unpleasant discussion with the customers about the quantity of water they consume. The advantages derived by consumers from being supplied by metres, are,—first, that each consumer pays only for the water actually used by him, whereas, at present he must pay also his share of all the waste that is going on;—secondly, the metre is useful to the customer for regulating the distribution of water on his own premises, and for preventing waste by his own servants;—and thirdly, the general prevention of waste will enable water companies to reduce their charges.

There are many other useful applications of an efficient, cheap, and compact water metre, one of the most important of which, is the application to steam boilers. By inserting a metre into the suction pipe of the feed pump, a correct indication is obtained of the water actually evaporated, which serves as a check on the one hand upon the performance of the engine, and on the other hand upon the quality of the fuel employed, or the care of the fireman in burning it.

There are at present upwards of 2000 of these metres in constant use at several large towns in this country, including London, Bristol, Edinburgh, Newcastle, Yarmouth, and Leeds; and also upon the continent, at Berlin, Amsterdam, and elsewhere.

The sizes of the metres vary from ½-inch to 12 inches diameter of supply pipe; and excepting the comparatively few cases of defective metres above alluded to, which, according to a careful register kept by the manufacturers, have amounted to not more than 33 cases in a year

out of about 1500, the results have been highly satisfactory as regards both the correctness of measurement and the durability of the metre.

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Mr. Siemens exhibited several metres of different sizes, and specimens of the revolving drums, from the smallest size, with a drum 1½ inches diameter, intended for a pipe ½-inch diameter, delivering 5 gallons per minute, up to one of the largest size, with a drum 8 inches diameter, intended for a main 10 inches diameter, delivering 500 gallons per minute. A ½-inch metre was also exhibited, and shown in operation at the meeting at various rates of discharge, having a glass casing, allowing the motion of the rotating drum to be seen while in action.

The Chairman observed, that there had been hitherto much difficulty in obtaining a correctly registering metre; and now that water was so much more generally introduced by water companies, into houses, &c., it was important to have an accurate and durable metre, that could be fully relied upon.

Mr. Allen inquired whether the drum would make many revolutions by its momentum, after a sudden stoppage of the discharge; he thought that it would be liable to do so, especially under a high pressure or a great velocity, and that the metre would then register too large a quantity.

Mr. Siemens replied, that the tendency of the drum to overrun, when the discharge was stopped, was now successfully prevented by the retarding vanes fixed upon it, by the resistance of which, in the stationary water, it was speedily brought to rest. It had been ascertained by experiment, that when the drum was rotating at 2000 revolutions per minute, only 5 or 6 revolutions were made by it after the discharge had been suddenly stopped; and the little error arising from this cause was nearly compensated for, by the effect produced by the inertia of the drum at the commencement of motion—a small quantity of water having to pass through the drum not registered, before the drum had attained the velocity, corresponding with the velocity of the water through the metre. As an extreme test, he might mention an instance in which a metre had been used to measure the water supplied to an engine boiler, and had been placed between the feed pump and the boiler, and consequently, the drum was set in motion and stopped at each stroke of the pump, and went with jerks; but even under this severe trial, the metre was found to register only about 5 per cent. in excess. In such a case it would be necessary to provide an air vessel to equalize the flow through the metre; but even without such addition, the amount of loss at each stoppage was evidently very small.

Mr. Greaves, of the East London Water-Works, was particularly glad to be able to bestow praise on the present invention, having so often been unable to form a favorable opinion of water metres. He had paid considerable attention to the several metres that had been brought forward, and the first that occurred to him as having been practically useful, was that by Sterling, whose metre was formed of a horizontal revolving drum; this was, however, found faulty, and could not be used under high pressures. The original screw metre, invented by Mr. Siemens, had proved defective. Piston metres, consisting of a piston driven

up and down in a cylinder by the water, which was admitted alternately at the top and bottom of the cylinder, had been frequently attempted, but unsuccessfully. Trials had also been made of double-chambered metres with door pistons, which might be said to consist of a pair of coupled engines worked backwards; but elastic diaphragms, as used for gas, were not suitable for water. In Siemens' new metre, now under consideration, the measurement of the water depended on the principal of reaction; the drum being caused to rotate by the reaction of the water in passing through it. After having experimented carefully on all the above metres, he had found that of Mr. Siemens to be the best, and it had proved very satisfactory in working. Of the other metres, he preferred that by Kennedy, of Kilmarnock.

The great difficulty to be encountered had been to produce a metre that would answer equally well under all varieties of pressure and velocity, and would transmit the full pressure of the water. He believed the previous metres had failed of accomplishing this fully, but it appeared to be attained in the present instance. Mr. Siemens' metre, the addition of the retarding vanes on the drum, was an important point, as the increasing resistance they encountered from the water checked the drum, and counteracted the tendency that it had to rotate at an increasing speed, which would otherwise produce an error in the registration. At the East London Water-Works, a large number of these metres of various sizes, were being used at the present time; of which 16 were ½ inch, 18—¾ inch; 31—1 inch; 16—1¼ inch; 17—1½ inch; 43—2 inch; 17—3 inch; 7—4 inch; and 2—6 inch. The total quantity of water supplied through these metres, was 2,000,000 gallons per day, at a minimum value of 6d. per 1000 gallons, and a correct measurement was, therefore, a matter of great importance; this being, he believed, a larger quantity of water than was measured through metres by any other parties, although he understood that Mr. Bell, of Bristol, was using a greater number of metres.

The defects that had come under his observation in the working of the metres had not been serious, and were defects in construction, not in principle; in the earlier metres, some of the drums and the retarding vanes had been broken, the spindles burred, or the gearing of the counting apparatus injured, but there had been very few stoppages of the latter made metre from any cause.

The Chairman inquired for how long a period he had been making trials of the different metres that had been introduced, and how long he had had Siemens' metre in regular use.

Mr. Greaves said that the East London Water-Works Company had been occupied for 15 years in experiments on metres, in which about £1000 had been expended. His predecessor, Mr. Wicksteed, had taken great pains to arrive at a satisfactory metre, but without success, and had himself made a machine for the purpose, having a double set of double-beat valves, forming in fact a water pressure engine. Other metres also were made, fitted with slides, but it was found difficult to adjust the working of the tumblers to the varying pressure, and the apparatus proved noisy and inconvenient. It was essential to a metre that was to be generally adopted, that it should not be troublesome to

the consumers, or they would not use it. He had now had the metre of Mr. Siemens, in its improved form, in regular use about twelve months, and it appeared to fulfil all the requirements of a good and durable metre. It was important, that in case of any injury or stoppage of the metre, the consumer should not suffer thereby, and in this respect there was an objection to all piston metres, for though they might register equally accurately with others whilst in working order, yet if ever they happened to break down, the flow of water was stopped. In Mr. Siemens' metre, on the other hand, if a break down occurred, the flow of the water was not interrupted, and the loss was entirely on the side of the company. In the case of some manufactories, such as sugar works, much damage had been known to accrue from an accidental stoppage in the supply of water, and it was desirable to avoid the serious consequences of such an accident, even at the expense of some loss of water charge, from the metre standing still a day or two; the principle in every instance being that the metre ought to break down against the company, and not against the consumer.

Mr. Bell, of the Bristol Water-Works, said he had used a large number of the metres described in the paper, and had been well satisfied with them: he had brought one of them for the purpose of showing at the meeting the actual results of working. The metre was now, for the first time, taken to pieces since first putting to work, having been in constant work for two years, and it was found in complete order, with very slight signs of wear in any parts, after having measured many thousand gallons of water. It had been used first at a sugar-house, and when tested, on being removed from the house, gave about 2½ per cent. against the company: it was replaced by another metre in about five minutes, and was then taken to the Clifton Baths, and after being used there for some time longer, was again tested, when it was found to be less than 3 per cent. in error against the company, registering 972 gallons instead of 1000. The metres that he used were all tested by means of a 1000 gallon tank, the contents of which were run out through the metre, and the indication noted. It was necessary, in Bristol, to be very careful in the use of metres, as the water had previously been much wasted, and a sea of water would be needed to supply all the waste that would otherwise take place—no springs being sufficient.

He had tried the improved metres of Mr. Siemens under pressures, varying from 25 to 50 and 60 lbs. per square inch, and had found them equally correct under all: he had now 326 of them at work, some having been down two years, and used 1 inch metres to supply 2000 gallons per hour, and ½ inch metres for 400 gallons per hour. He had tested several other rotary as well as piston metres, but none of them were quite satisfactory, as some water was allowed to pass through without being measured. In the piston metre, the cock, by which the entrance and discharge of the water was regulated, was of large size, and he had found it sometimes happen that the tumbler had not power enough to turn the cock over, causing the metre to stand still, and stopping the flow of water.

Mr. Forsyth inquired whether the rolling packing ring, used in Kennedy's piston metre, had been found to be durable: it appeared an

ingenious way of getting over the difficulty of packing in a piston metre with little friction, and he had understood it had proved successful.

Mr. Bell replied that he had not had sufficiently long experience of the rolling packing ring to ascertain its durability, having found the metre was not satisfactory in accuracy of measurement.

Mr. Crimes remarked, as the maker of the metre, that the specimen exhibited by Mr. Bell, had been made on the old pattern, at an earlier period of the manufacture, and many improvements in detail of construction had been introduced since that time: the drum was now made of stamped corrugated metal, and considerably lighter, and being well balanced all round, it was probable that the spindle barely touched the sides of the socket at a high velocity of rotation; coming in contact with the socket only at a slower speed. The bearings of the spindle were now increased to nearly three times the original length, in order to prevent the slight wear that was perceptible in the old specimen that had been exhibited. He might mention an unusual experiment that he had recently made, which showed the applicability of the metre to the smallest pressures: in this case, the Lancashire and Yorkshire Railway Company required a metre to measure water out of a canal into a reservoir, which when full was level with the canal, and there was found to be a variation of measurement of only 2 per cent., when the difference of level was reduced to only 3 inches; showing the correctness of measurement under a head of water of only 3 inches, as well as under one of 150 feet.

Mr. Bell said he had tried a somewhat similar experiment with a 2-inch metre, causing 1000 gallons of water to pass through it, first in 16 minutes, then the same quantity in $2\frac{1}{3}$ hours, and lastly the same quantity in 16 hours, and under these great variations in the velocity of the water, the metre registered only 13 gallons less than the correct amount, 3000, being an error of less than $\frac{1}{2}$ per cent., and in favor of the consumer.

The Chairman inquired what oil was used to lubricate the spindle of the drum, a material being required that would continue uniformly liquid, and he thought common oil would not answer in this respect.

Mr. Siemens said that common oil was not suitable, but any oil might be used that was not acid, so as not to act upon the brass-work; pure olive oil and neat's foot oil answered well, or the oil extracted from peat. As a further precaution against corrosion the brass-work was tinned, and the success of the result was shown in the metre exhibited by Mr. Bell, which he had not seen before, and in which there was scarcely any wear after two years' work. This result might appear remarkable considering the high velocity of the drum, but he thought that the higher the velocity, the less wear there would be upon the bearings, because the drum would spin round in the manner of a top or gyroscope, and require in that state no lateral support whatever.

Mr. Crimes remarked that the oil was not required to lubricate the spindle, but was necessary merely to prevent the water entering that part of the metre, and producing a calcareous deposit on the bearing of the spindle: this purpose was indeed now effected with equal success by employing distilled water, but he preferred to continue using oil.

The Chairman thought the practical information that had been given in relation to the subject was very valuable; and the metre described in the paper, reflected great credit on the skill and perseverance of Mr. Siemens.

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*Boiler Explosions, and the Raising and Use of Steam.**

From the Report of the Committee of Management presented to the Second Annual Meeting of "the Association for the Prevention of Steam Boiler Explosions, and for Effecting Economy in the Raising and Use of Steam," held at the Town Hall, Manchester, on Tuesday, the 20th day of January, 1857, we learn that the number of firms registered as members on the 31st of December, 1856, is 462, with 1301 boilers in use at their works, which shows an increase in the number of members reported at the last annual meeting of 193, with 458 boilers. The committee trust that this may be regarded as an evidence that the extra security against accidents afforded by the periodical visits of the inspectors, and the amount of practical information acquired by them, and placed at the service of the members, is now being justly appreciated. During the past year 2246 visits have been made, and 1456 boilers examined by the chief and sub-inspectors. These visits disclosed that 143 boilers, or nearly 10 per cent. of the whole, were in a dangerous condition. No explosions have yet occurred upon the works of any of the members since the inspection began, although in Great Britain generally, not less than thirty-one boilers have exploded during the last year, causing the loss of fifty-eight lives, and serious injuries to upwards of seventy persons.

From the coroners' inquests, as to the causes of boiler explosions within the last year, it is inferred, in the absence of all reference by the witnesses (in so far as has been observed), to surcharged steam as the source of mischief, that this probable cause of accident is little known or suspected. "The fact that steam while in contact with water may be surcharged with heat to a very high degree, without any greater effect on the pressure gauge, or safety valve, than is due to ordinary gaseous expansion, rests," says the Report, "upon the undoubted authority of scientific inquirers. Thus, there *may* accumulate within the boilers a latent force in the form of superabundant heat, which, on the disturbance of the water from any cause, *may* combine suddenly with it, producing steam of excessive pressure, resulting in an explosion." As this conclusion is not universally admitted, even by those who are acquainted with the scientific fact on which *the inference* rests, and is not even known or suspected by most practical men employed about steam boilers, it appears to be a case which calls for a practical solution from the Association, and means will probably be taken within the next year, at the expense of the entrance fee fund, to determine experimentally this important point.

The following remarks are condensed from the Report (dated January

* From the Lond. Mech. Mag., January, 1857.

12th, 1857), made by the chief inspector, Mr. R. B. Longridge, of Manchester, to the Committee of Management:

Causes of Boiler Explosions. 1. *Over pressure.*—Boilers working at a dangerous pressure were principally old Butterley boilers, or cylindrical boilers of large diameter, with few or no stays, and not originally intended for so high a pressure. Several have been replaced, and others strengthened by additional stays, or the pressure has been reduced.

2. *Corrosion and failure of plates.*—The corrosion frequently observed in the interior of boilers is caused by the presence of acids in the water. The remedy is the regular use of lime, potash, or other alkali, to neutralize the acid. Where dampness exists in the seating of a boiler, oxidation of the iron ensues, and the plates are rapidly wasted away. Should this arise from any extraneous cause, the remedy is obvious; but where, as often happens, the dampness is produced by leakage from the seams or fractured plates, this is usually attributed to defective materials or workmanship. Although this often does contribute to such failure, it is not the primary cause. In the majority of cases, leakage and fracture of the plates at the underside of a boiler originate from imperfect circulation of the water. In multitubular boilers, where the greatest heat exists in the upper rows of tubes, the water at the bottom remains comparatively cool and undisturbed, and these boilers are especially liable to leakage. In flued boilers, with furnaces in the flues, one of the seams on the underside, about the middle of the boiler, is often found fractured between the rivet holes throughout a considerable portion of the semi-circumference. In cylindrical boilers, with external furnaces, the steam, rising from the bottom, prevents a regular descending current of water, and any mud or sediment settling on the plates and lying undisturbed, allows them to become overheated, fractured, or even burnt away. Several examples of this kind might be adduced. To remedy these evils, fix in the boiler sheets of iron to separate the ascending and descending currents, or where this cannot be arranged for want of space, convey a large pipe, communicating with the upper part of the water, underneath or within the boiler, with several branch pipes to supply water for the ascending current. The advantage derived would not be confined to the durability of the boiler, but would also contribute to an increased evaporation of water. No point connected with the construction of boilers more deserves the attention of engineers.

3. *Safety valves.*—Although not unfrequently safety valves are found inoperative, from negligence or recklessness on the part of the attendant, this is not a common cause of explosion. The danger of explosion, from the ignorance of the attendants, is considerably diminished by the almost universal use of pressure gauges; but, although these are valuable for indicating the rising or falling of the steam, they should never be considered as substitutes for safety valves. It is a very common but dangerous practice to weight safety valves to correspond with pressure gauges. As an additional precaution, every boiler, or set of boilers, should be provided with an indicator tap to test the gauges.

4. *Water gauges.*—The glass tube is the most perfect gauge for showing the height of the water, and much preferable to the float, on account

of the difficulty of keeping the float-wire sufficiently free to act, without escape of steam at the packing. Where the glass gauges were found inoperative, the passages had been choked with sediment, to which they are very liable where the water is dirty, unless frequently blown through. Such obstructions only show want of attention on the part of the fireman.

5. *Injury resulting from deficiency of water.*—This is a very frequent and most serious source of danger. When flues become overheated from deficiency of water, the temperature of the steam increases in a much higher ratio than the pressure, and the pressure gauge is no longer a true indicator of danger. Many examples prove that whenever heat is communicated to a boiler above the water level, the steam must be surcharged in a greater or less degree, without a corresponding increase of pressure. The water being allowed to fall too low, or the external flues being carried too high, produces the same effect. To provide against this danger, every boiler should be provided with efficient fusible plugs, or safety valves, connected with floats, either of which should be arranged to come into operation and allow the escape of steam, before the water could reach a dangerous level. Where, however, a boiler is already in danger from this cause, the best course to be pursued is to draw or damp the fire, and then leave the boiler to cool, carefully avoiding any measures which might cause agitation of the water, such as starting the engine or opening any of the valves.

On the construction of boilers.—In the Manchester district, boilers of the Cornish or flued construction, from their adaptation to a higher pressure than Wagon and Butterley boilers, have to a great extent superseded these, and though inferior in strength to plain cylindrical boilers, generally receive the preference, on account of superior economy in generating steam. The weakest point in these boilers are the flues, which, in case of deficiency of water, are very liable to collapse. It has not been satisfactorily ascertained what pressure such flues are capable of sustaining, but by some late experiments it has been proved that the strength of cylindrical vessels subjected to external pressure is in the inverse proportion to their length, a fact which seems hitherto to have been unknown, or at any rate disregarded. It seems, on this account, advisable in high pressure boilers of this construction to strengthen the internal flues, if of considerable length, by external rings of T, or angle iron, or, which would be preferable, to join the plates with flanched seams, commonly known by the name of "Adamson's patent seams." As the experiments referred to were only conducted on a small scale, it is highly desirable that further experiments should be undertaken.

The cylindrical boilers without internal flues, though well adapted to high pressure, do not contrast favorably with flued boilers, in economy of fuel. The Galloway or multiflued boilers are much approved of by many, but multitubular boilers will be found the most economical, though hitherto the necessity of frequent repairs has brought them into much disrepute. The difficulty of removing incrustation from the tubes may in most if not in all cases be overcome, by the use of sediment collectors, chemical ingredients, or frequent blowing off.

In regard to the evaporating power of boilers, our present knowledge

is very imperfect. The true test of the merits of a boiler, is the weight of water evaporated per pound of coal under a given pressure and in a given time, which can only be ascertained by means of an accurate water metre. Some experiments made in one of Hill's multiflued boilers, with Kennedy's water metre, give an average evaporation of 7·5 lbs. of water per lb. of ordinary Lancashire coal, under a pressure of 45 lbs. per square inch, the rate of combustion being 12·9 lbs. of coal per square foot of grate per hour, and the temperature of the feed water 82°. In the course of the present year further experiments will, it is hoped, be made.

Smoke prevention.—This subject has received considerable attention, and although the progress made in this direction is very limited, it is gratifying to find that a more perfect knowledge of the subject has had the effect of removing much of the prejudice which hitherto existed. Several examples might be adduced to prove both the possibility and advantage of smoke prevention in regard to economy, "but the whole subject," says Mr. Longridge, "has been so thoroughly investigated and explained by Mr. Charles Wye Williams, in his Essay and Treatise on Combustion, that it is quite unnecessary for me here to enter upon it, excepting to add my testimony to the truth of the principles therein expounded."

It may be useful, however, to warn those who feel disposed to act upon Mr. Williams' suggestions, against an error into which many have fallen, in concluding that what succeeds in one boiler must necessarily succeed in all others of the same dimensions, and with the same arrangement of the flues. This does not necessarily follow, for unless in each case there be sufficient draft to bring the due proportion of atmospheric air into contact with the carbon and the gases, the combustion will be imperfect, and since, in some boilers, twice or three times as much fuel is burnt in a given time upon the same area of fire-grate as in others, it is obvious that, in the former, twice or three times as much atmospheric air will also be required. It is from inattention to these different conditions that instances of failure are heard of. The principle is unquestionably correct, and only requires to be thoroughly understood to be applied with success.

Cause of boiler explosions.—The majority of these explosions resulted from inattention to the supply of water.

Steam Engines. *High-pressure steam.*—The economy of high-pressure steam is now generally admitted, but there appears to me to be much misapprehension as to the source of this economy. By many it is imagined that it is derived principally from its generation in the boiler. This opinion seems to have been formed from the observed fact, that the pressure increases in a rapidly accelerating progression—in other words, the higher the pressure, the more rapid the increase. But it has been satisfactorily proved, that the quantity of fuel required to evaporate a given quantity of water increases with the pressure; that is to say, it requires more fuel to evaporate a given weight of water under 60 lbs. than under 10 lbs. pressure, from which we may conclude that no economy will result from the generation of steam at an increased pressure, unless accompanied by a proper use of it in the engine.

Of non-condensing engines it is only observed that in order to work

with the greatest economy, it is necessary so to arrange the valves that the steam will be reduced by expansion nearly to atmospheric pressure before escaping from the cylinder.

In *Condensing engines* the steam should be cut off at such a portion of the stroke, that at its termination the pressure of the steam will be reduced by expansion to 8 lbs. or 10 lbs. below that of the atmosphere, previous to passing into the condenser. Otherwise the steam has not done its full work. If, therefore, it be required to expand the steam to this low pressure—say 7 lbs. total pressure—and the valve be arranged to cut off at one-fifth of the stroke, the initial pressure should be 35 lbs. or 20 lbs. above that of the atmosphere, and if 10 lbs. additional be allowed in the boiler, which is more than absolutely necessary, we have 30 lbs. per square inch, beyond which there is no advantage in raising the steam for this class of engine, cutting off at one-fifth of the stroke. We find, however, examples where the boiler pressure is nearly double this amount, while the initial pressure in the cylinder does not exceed 12 lbs. or 14 lbs. per square inch. This arises partly from the mistaken ideas above mentioned, and partly from errors in the arrangement of the valves.

In order to work more expansively and economize fuel, it is usual, where slide-valves are employed, to increase the lap or cover of the valve that it may close earlier; but when this is done it is found that the engine will not drive its load unless the boiler pressure be increased; the explanation is, that the additional lap on the valve has so contracted the opening of the port, that the steam can only enter the cylinder at a greatly reduced pressure. By properly proportioning the lap and travel of the valve, the same result might be obtained without any increase of the boiler pressure.

Another error is, the common practice of cutting out a small piece on the steam side of the valve, in the shape of a V, to admit the steam more gradually to the cylinder, and thus prevent a sudden shock to the engine in passing the centres. To some extent this effect may be produced, but there will at the same time be the disadvantage of wire-drawing the steam, and admitting it to the cylinder when the valve ought to be entirely closed. A better remedy is the following:

So arrange the valve as to close the exhaust port before the termination of the stroke; the steam within the cylinder will then be compressed as the piston continues its course, and will increase in pressure as the space occupied is diminished. By properly proportioning the degree of compression to the initial pressure on the piston, all shock in passing the centres will be obviated, and steam economized. Wherever this has been adopted, it has given the most satisfactory results, and its adoption must eventually become general.

Compound Engines.—These remarks on the arrangement of the valves apply equally to engines working compound. This system, of late brought much into use, is found in some instances to give very satisfactory results, and where additional power is required, is frequently the most convenient mode of obtaining it; but in comparing the best engines of each system, there does not appear that decided superiority in economy in compound engines which might have been anticipated from

the greater pressure of steam. The indicator diagrams show that in all engines working compound, there is a loss of pressure, as the steam passes from the high to the low-pressure cylinder, the amount varying according to the arrangement of the valves and the capacity of the passages of communication. What is chiefly required to improve the condensing engine, and make it equal in economy to the compound engine, is a simple variable expansion motion capable of regulating the supply of steam according to the load, without any reduction in the initial pressure, an evil to which most engines are now subjected by the action of the throttle valve. The present valve motions which have this for their object, appear to be too complicated to be brought into general use.

Spheroidal State of Water.

The ordinary explanation of the spheroidal of water assumes that the drop of liquid is separated from the heated plate by an atmosphere of its vapor, which prevents the full transmission of the heat. And this view seemed to be confirmed by experiment and by observation. M. Buff (*Annal. der Chemie. und Pharm.*, *t.* lxxvii. p. 1), rejects this theory, however, on the ground that when the mass of water is great, an electrical current will pass, and he attributes the phenomena to a change of the capillary forces, the liquid ceasing to moisten the solid. The explanation does not appear to us satisfactory. In the first place, the saturated vapor may pass a portion of an electrical current, and the mere change in the ratio of the forces does not account for the very slow evaporation of the liquid, which is the curious part of the phenomenon.

For the Journal of the Franklin Institute.

Description of Coal-burning Freight Engines, used on the Mine-Hill and Schuylkill Haven Railroad, as Improved by R. A. Wilder, Engineer in Chief of said Road. [Built by M. W. Baldwin & Co.]

A represents an apparatus for cleaning coal fires by the power of the engine while running upon the road. It is placed under the grate bars, with the ends of the teeth or fingers always between them, but so far below the fire as not to be affected by it. When the cinder and ashes have accumulated upon the grates, sufficiently to obstruct the draft, the fireman draws the lever A back to the notch, by which means the fingers of the "raker" are raised between the grates into the fire, and at the same time the apparatus is thrown into motion by connecting it with an eccentric, placed on one of the driving axles of the engine. When the grates are cleaned, (which is but a momentary operation,) the lever is released, and the "raker" drops back to its former position.

This improvement enables the fireman, without any physical labor, to keep the grates free from cinder and ashes, and avoid the necessity of stopping to rebuild his fires; thus removing the great obstacle at the present time, to the successful use of anthracite coal in engines of ordinary construction.

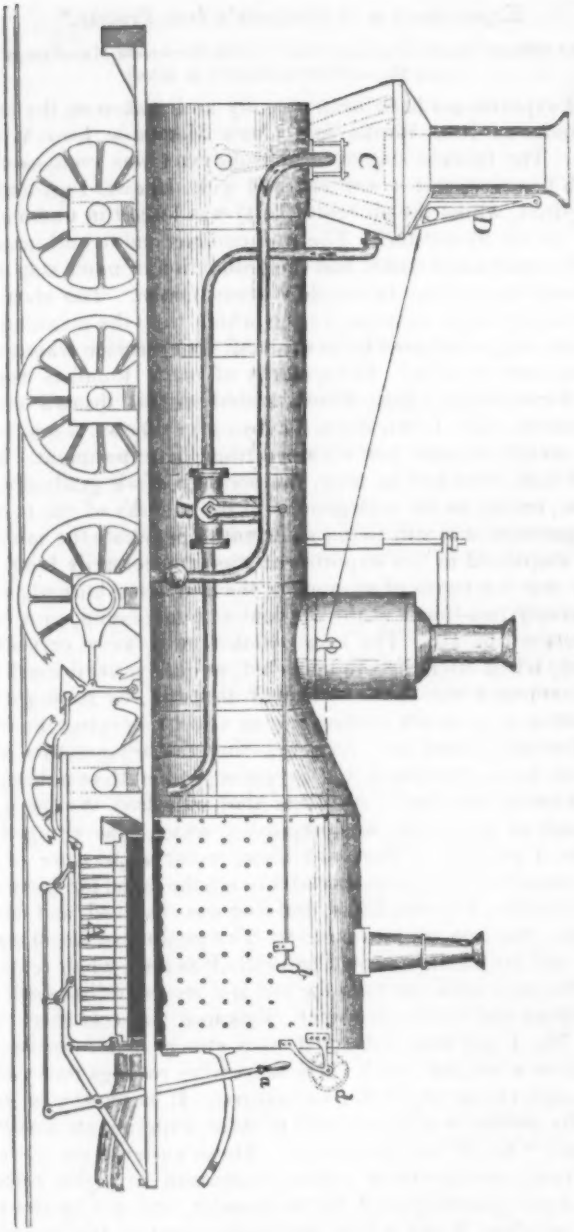
B is a simple arrangement for regulating the supply of feed water to the boiler, by means of a two-way valve and overflow pipe. The pump is always working when the engine is in motion; the indicated position of the arm which moves the valve, shows the water to be passing to the boiler. By drawing back the rod *b*, the overflow pipe is opened, and as the pressure of the steam in the boiler keeps down the check, the water must pass back to the tank. By placing the valve at any point between the two positions described, any portion of the water can be fed to the boiler, and the surplus be discharged through the overflow pipe to the tank.

By this arrangement the supply of water to the boiler can be kept nearly uniform; and in cold weather the freezing of the pump will be prevented.

C is a feed-water heater and spark arrester for the locomotive: it consists of an outside casing, which forms the base of the smoke pipe—a water vessel containing from fifteen to twenty gallons, and a netting of coarse wire, all placed concentric with each other, but far enough apart to insure plenty of draft. The parallel dotted lines represent the water vessel, with the straight portion extending down into the smoke box; the inside dotted lines show the spark arrester, attached to an arched plate, which is placed above the water vessel, and connects the external with the internal flues. The narrow part of the spark arrester is placed over the exhaust pipes in such a way, as to arrest the sparks, but admit the free passage of the exhaust steam through the open stack to the external atmosphere. This improvement is simple and durable, requiring few repairs except to renew the wire netting about once a year.

D is an arrangement for increasing and diminishing at pleasure the effect of the blast from the exhaust steam. It consists of a short straight pipe, permanently fastened to the top of the heating chamber, and another of equal length, which slides over it. A light iron stand as high as it is desirable to raise the outside pipe is placed on one side, with grooved pulleys at the top and bottom; a small wire cord is made fast to the bottom of the outside pipe, and passed over the upper pulley and under the lower one, and thence back to a small winch placed on the end of the boiler, convenient to the fireman. On the side of the pipe opposite the cord attachment, is a friction roller, to prevent the pipe from jamming while being raised and lowered. When the blast needs increasing, the fireman raises the stack by turning the winch, and fastens it by a pawl to prevent it from sliding down again, till the coal is thoroughly ignited. When sufficient steam is raised and the fire burns clearly, the winch is loosened, and the stack lowered by its weight to its former position. It will be seen that the stack may be secured at any point, between the lowest and highest elevation, so as to secure a regular draft adapted to the requirements of the engine.

This arrangement possesses some advantages over the usual method of increasing and diminishing the orifice of the exhaust pipe to regulate the blast, because the power of the cylinder is not affected by it; nor does it influence the vertical passage of the exhaust steam; it is not liable to get out of order, and can be readily repaired or renewed.


C
D
B
a
a

*Experiments with Bessemer's Iron Process.**

[From the Official Report of a paper read by Dr. Stevenson Macadam, F. R. S. E., at the Royal Scottish Society of Arts.]

Several experiments have been recently undertaken on the large scale at the Dundyvan Iron Works and Coats Malleable Iron Works, near Glasgow. The furnace employed at Dundyvan was composed of iron, lined with fire-clay, and it was charged with 13 cwt. 1 qr. and 8 lbs. of No. 2 pig-iron, whilst the air (cold blast) was forced in under a pressure of 15 lbs. on the square inch. The iron commenced to boil immediately, followed by sparks and flame, and the production of much slag or cinder, which caused the furnace to overflow occasionally. The blast was continued for eighty-nine minutes, during which time the scintillations, jets of flame and slag, continued to be evolved. The furnace was tapped, and the iron run into moulds. The quantity of metal found in the moulds was only 3 cwt. 3 qrs. 2 lbs., which, added to that thrown out during the operations, viz: 1 cwt. 3 qrs. 12 lbs., gives 5 cwt. 2 qrs. 14 lbs. as the entire weight of pure iron obtained from the experiment. It may be mentioned that, after half an hour, the pressure of air gradually decreased to 5 lbs., owing to the enlargement of the mouths of the tuyeres, but the latter pressure was still found sufficient to penetrate the molten mass. The time employed in this experiment was unnecessarily long, and undoubtedly was the cause of so much of the iron being burned away. The loss was nearly two-thirds of the original amount, being, in round numbers, 8 parts out of 13. The iron obtained was very crystalline and brittle, and, when attempted to be rolled, at once proved itself to be *hot short*. An attempt was made to anneal this iron, by raising it to a red heat, and then very slowly cooling it; as also by keeping the mass at a red heat for sixty hours, and then lowering the temperature very gradually; but both attempts failed in giving other than a highly crystalline and brittle product. At Coats Malleable Iron Works, a circular furnace, built of fire brick, was employed, which was charged with 7 cwt. of No. 1 pig iron. The cold blast, under a pressure of 12 lbs., which decreased to 5 lbs., was forced through the metal for thirty minutes. The usual display of sparks, flame, and slag was observed, and the furnace being tapped, the iron ran into moulds. The product or *bloom* was highly crystalline and brittle when heated and rolled; as also, when reheated and re-rolled, the rods obtained from the first and second rollings still retained this crystalline and brittle character. This iron was *cold short*. Another trial with No. 1 pig iron, subjected to a stream of air for twenty-four minutes, gave a similar result; the successive rollings not yielding an iron of a tough character, or fibrous texture. It is worthy of consideration that the quality of pig iron used in these experiments was "No. 1" at Coats, and "No. 2" at Dundyvan. These varieties are more fusible than the others, contain more carbon, command a higher price in the market, and are generally used by the founder, and not by the puddler. The varieties "Nos. 3 and 4" are generally used in the conversion of pig iron into bar iron. One trial has been made at Coats on No. 4 pig iron, but in fifteen minutes the metal settled down in the furnace; and

* From the Lond. Mech. Mag., Jan., 1857.

though it was immediately tapped, yet the iron did not run off, and the furnace was taken to pieces to liberate its iron prisoner.

To a certain extent, the ordinary refinery furnace is the equivalent of the Bessemer furnace, as it is quite possible for all the impurities contained in pig iron to be got rid of in the refinery furnace, with the single exception of the carbon. Moreover, when the pig iron is placed in the Bessemer furnace for a short time, in place of the ordinary refinery, and thereafter introduced into the puddling furnace, a very superior bar iron is the result, as proved by an experiment conducted on a somewhat large scale at Coats Malleable Iron Works.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, May 21, 1857.

John Agnew, Vice President, in the chair.

John F. Frazer, Treasurer.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

A Letter was read from the Polytechnic Institute, of the Kingdom of Bavaria.

Donations to the Library were received from The Commissioners of Patents, and from the Statistical Society of London; The Polytechnic Institute of Bavaria, Munich; L. A. H. Latour, Esq., Montreal, Lower Canada; J. Ross Snowden, Esq., Dr. H. Hartshorn, and Prof. B. H. Rand, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute, were laid on the table.

The Treasurer's statement of the receipts and payments for the month of April was read.

The Board of Managers and Standing Committees reported their minutes.

Three resignations of membership in the Institute were read and accepted.

Candidates for membership in the Institute (3) were proposed, and the candidates proposed at the last meeting (3) were duly elected.

Mr. H. Howson exhibited and explained the following models—Harvester Rake, by Samuel Comfort, Jr., Morrisville, Pa. This invention is applicable to the M'Cormic, Ketchum, and similar class of Harvesters.

The apparatus is free from the rubbing surfaces common to the devices used for a like purpose. It is a most ingenious contrivance, and one containing mechanical movements of an entirely novel character.

Harvester, by Samuel Comfort, Jr., patented March 18th, 1856. The novelty of this Harvester, consists in the employment of an endless chain of cutters, which pass over the top of the cutter bar a sufficient height to allow the grain to fall below the same. A further novelty consists in a series of bent or twisted springs, which act on the blades as they traverse a recess in the cutter bar, in such a manner, as to increase their

cutting effect. This Harvester was put into successful operation last season, and found to be remarkably light and easy as regards draft.

Rotary Harvester Rake, by Samuel C. Longshore, Bucks County, Pa. The object of this invention, is to deposit the grain or grass in swathes. This rake is of a very novel character, and if found successful will prove of great value to farmers.

Rotary Cow Catcher, by William Braddock, of Medford, N. J. The rotating cone is substituted for the ordinary permanent grated cow catcher, for the double purpose of throwing the cows, &c. on one side of the track, and preventing the fracture of their limbs which are apt to become entangled in ordinary cow catchers. The operations of this contrivance are assisted by a curved shield in front.

Furnace Grate, by Richard Van Velthoven, of Philadelphia. The object of this invention, is to avoid the necessity of raking out the ashes which collect at the back of the furnace, through the front of the same. It consists of a simple drop or swivel grate, under the command of the attending engineer. By using this contrivance there can be no necessity of disturbing the fuel on the front portion of the grate, and consequently, a great saving of time and labor is effected.

Model for converting Rotary into Reciprocating movement, by Samuel C. Longshore, Bucks County, Pa. This contrivance is intended to impart a reciprocating motion to the cutters of harvesters, saw mills, &c. The principle is not claimed as new, but only the general arrangement.

Mr. Howson also showed a Gas Lighting Lamp, Invented by Abel Wilson, of Frankford, Pa., and some specimens of Ornamental Knitted Fabric, made by a machine invented by Joseph Vickerstaff, of Philadelphia.

Dr. Rand exhibited specimens of sugar from the Imphe or African Sugar-cane ; also a specimen of spirits obtained from the same.

Specimens of Garrett's Composition Metal for lining shaft journals, were presented to the notice of the members.

It is said to possess all the anti-friction qualities of the composition known as Babbett's, with the greater additional advantage of requiring about twice the heat to melt it, which will, no doubt, recommend it to the favorable consideration of those engineers who sometimes melt out a box. It is composed of zinc, copper, and antimony ; the first metal predominating largely. In filling the brasses, which are recessed in the usual way, they are heated, and the metal, which should be just above the melting point, is poured in, and after setting, is hammered to close all the cavities, should any be left after filling. The metal is hard and close, and is said to answer its purpose excellently. Upon the Baltimore and Ohio Railroad it has been in use for several months with satisfactory results; and, Messrs. Merrick & Sons have lined the boxes of the U. S. Steamer *Wabash* with it. A fair comparison of the qualities of Garrett's and Babbett's will thus be made, as the five other steamers last built by the Government, were furnished with Babbett's metal for all the journals.

COMMITTEE ON SCIENCE AND THE ARTS.

Report on Mr. Seth E. Winslow's Safety Can and Lamp for Spirit-gas.

The Committee on Science and the Arts constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination a Safety Can and Lamp for Spirit-gas, invented by Mr. SETH E. WINSLOW, of Philadelphia, Penn.,

REPORT:—That the improvement claimed, consists in the use of a wire gauze diaphragm of conical form extending from the mouth inward like a bag. The gauze for the can is double for greater safety; the gauze in the lamp is single only, and is perforated below, the lampwick passing through the orifice. The can has, moreover, an air-tube passing from the spout near its mouth to the body of the can just under the cork, so that the fluid may be poured steadily without removing the cork. This is not, however, claimed as new.

Diaphragms of wire gauze so well known and so long used for the purpose of preventing the propagation of explosions, have been heretofore employed in burning fluid lamps and cans in one of two forms; either as plane transverse diaphragms stretching across the neck below the stopper, which present a very small surface for the passage of the fluid, and are liable to be clogged by sediment, and to be broken by thrusting the cork too far in, or by other violence; or in lamps, as cylinders extending from the top to the bottom of the lamp, within which the lamp-wick is contained. This latter form allows too much space for the fluid within it, and an explosion may be sufficiently violent to tear the gauze, or, although not extending to the liquid in the body of the lamp, may yet lead to serious damage.

This cannot be the case with the conical diaphragms, which, although simple, yet appear to the Committee to be a new and valuable improvement, adding materially to the safety of these very useful household utensils.

By order of the Committee,

Philadelphia, April 9th, 1857. WILLIAM HAMILTON, *Actuary.*

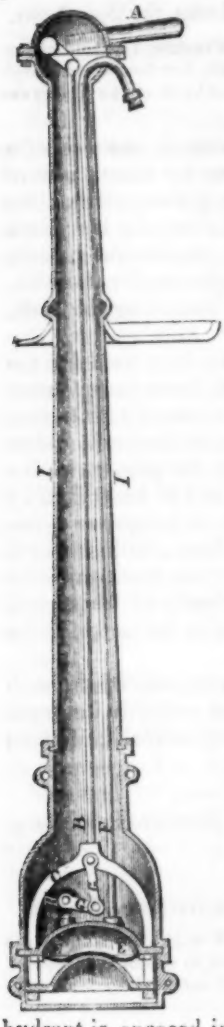
Report on Mr. James Cochran's non-wasting and non-freezing Hydrant.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination, "a non-wasting and non-freezing Hydrant, invented by Mr. JAMES COCHRAN, of the City of New York,

REPORT:—That they have examined the above named hydrant, and find it constructed as follows: A hollow cast iron body I, into which the feed pipe H, enters near the bottom, containing an immovable concave iron plate, and to which is attached a disk of gum elastic, E, acting as a movable bottom; under this is a convex piece of cast iron, D, also movable, which is attached by means of an iron yoke C, and cranks to a vertical rod B, and it to a lever handle A, at the top of said cast iron frame.

The supply and exit pipes enter through the immovable concave plate

into the box, formed by the plate and gum disk, so that all the water passes through this box.



Upon the supply is constructed a conical tap, so arranged that the water enters at one end in the direction of the taper, and is discharged through a rectangular port in the side, which is ¾-inch long and ¼-inch wide, so that a very small motion of the tap will open or close it entirely. The water acting in a longitudinal direction of the tap, as the tap wears by use, it is intended to be kept tight by the pressure of the water. This tap is attached by a combination of links and pinions to the yoke and rod before named. The handle is a lever of the second order with fulcrum at end, and the vertical rod is attached by means of a small rock shaft, so that by raising the handle the rod moves in the same direction. By raising the handle, the rod raises the convex plate, and it the gum; and after moving about one inch, the tap is opened and the water commences to flow. By letting go the handle the weight of the rod, yoke, &c., together with the pressure of the column of water, draws it down and closes the hydrant.

The pressure of the cast iron plate being taken from the bottom of the gum disk, the weight of the water from disk to point of exit is intended to press it down, and the capacity of the box being twice as great as the exit pipe, it empties the pipe, and the water returns again into the box.

Upon opening the hydrant by raising the handle, the convex plate is caused to ascend and press against the gum disk, forces the water contained in the box into the exit pipe, and a continuous stream follows. The tap is so arranged that it does not open until the disk has nearly reached its height, so that the water in the box is thrown into the pipe before more is admitted.

It is claimed, that this hydrant can be repaired without digging it up, which if so, is certainly a very desirable object gained. The iron post or hydrant is encased in a wooden box, which will not require repairing oftener than an ordinary hydrant.

When the supply pipe and gum box is placed a sufficient depth below the surface, (say about five feet, which is the depth the ground has sometimes frozen,) as there is no waste above the box, it is impossible to freeze.

In conclusion, the Committee take pleasure in recommending it as an ingenious contrivance, and worthy of trial.

By order of the Committee,

Philadelphia, April 9th, 1857. WILLIAM HAMILTON, *Actuary.*

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